

STUDIES OF A TROPICAL JUNGLE

INTRODUCTION

BY HENRY FAIRFIELD OSBORN

The British Guiana Kartabo Station of the Department of Tropical Research of the New York Zoological Society was founded in January, 1916, after many conferences of Henry Fairfield Osborn, Theodore Roosevelt, Madison Grant and William Beebe. The site chosen was the district immediately around Bartica, British Guiana, in typical tropical rain forest, sixty-five miles from the coast and at an elevation of only twenty-five feet. The Station itself is at Kartabo, at the point of junction of the Cuyuni and Mazaruni Rivers, where intensive research work has been carried on in a quarter of a square mile of jungle and shore.

Under the directorship of William Beebe, five expeditions have been made into this field. There have been thirty-six months of actual work, covering every season of the year. Research work at the Station has been carried on by thirty-three workers from America, England, Scotland and France, and three hundred and six visitors have been entertained. One hundred and fifty contributions have been published, including five bound volumes.

From the limited area under intensive investigation there have been collected notes, materials and specimens as follows:

- (1) Life history notes on 73 species of mammals, 464 species of birds, 130 species of reptiles and amphibians, and 150 species of fish.
- (2) Nests, eggs or breeding records of 206 species of birds, many new to science.
- (3) Skins, skulls and skeletons of 60 species and 750 individual mammals.
- (4) 1738 bird skins.
- (5) 126 bird embryos.
- (6) Hundreds of specimens of reptiles, amphibians and fish.

- (7) 85,000 insects, of which one item alone is the types of eighty-seven new species of termites.
- (9) 4,000 other invertebrates.
- (10) 550 KOH specimens.
- (11) 3000 photographic negatives.
- (12) 22,000 feet of motion picture film.
- (13) Specimens have been supplied to eight universities and five museums, while of living vertebrates there have been collected and sent to the New York Zoological Park 45 mammals, 215 birds, and 125 reptiles.
- (14) The chief collections of amphibians, reptiles, mammals and many invertebrates have been presented to the American Museum of Natural History.

It is interesting, in view of this successful prosecution of research work in the tropics, to consider the actual cost of the entire undertaking. From the beginning to the year 1924 the total income has been \$49,600. This has included the salary of the director, his assistant and chief artist, the steamship fares, entire scientific outfit, boats, tents, bungalow, household expenses, servants, hunters, taxidermists and the general accommodation for the staff of workers. The five expeditions have averaged six and a half months each, with an average of eight staff workers, the total average cost of each trip being \$9,920.

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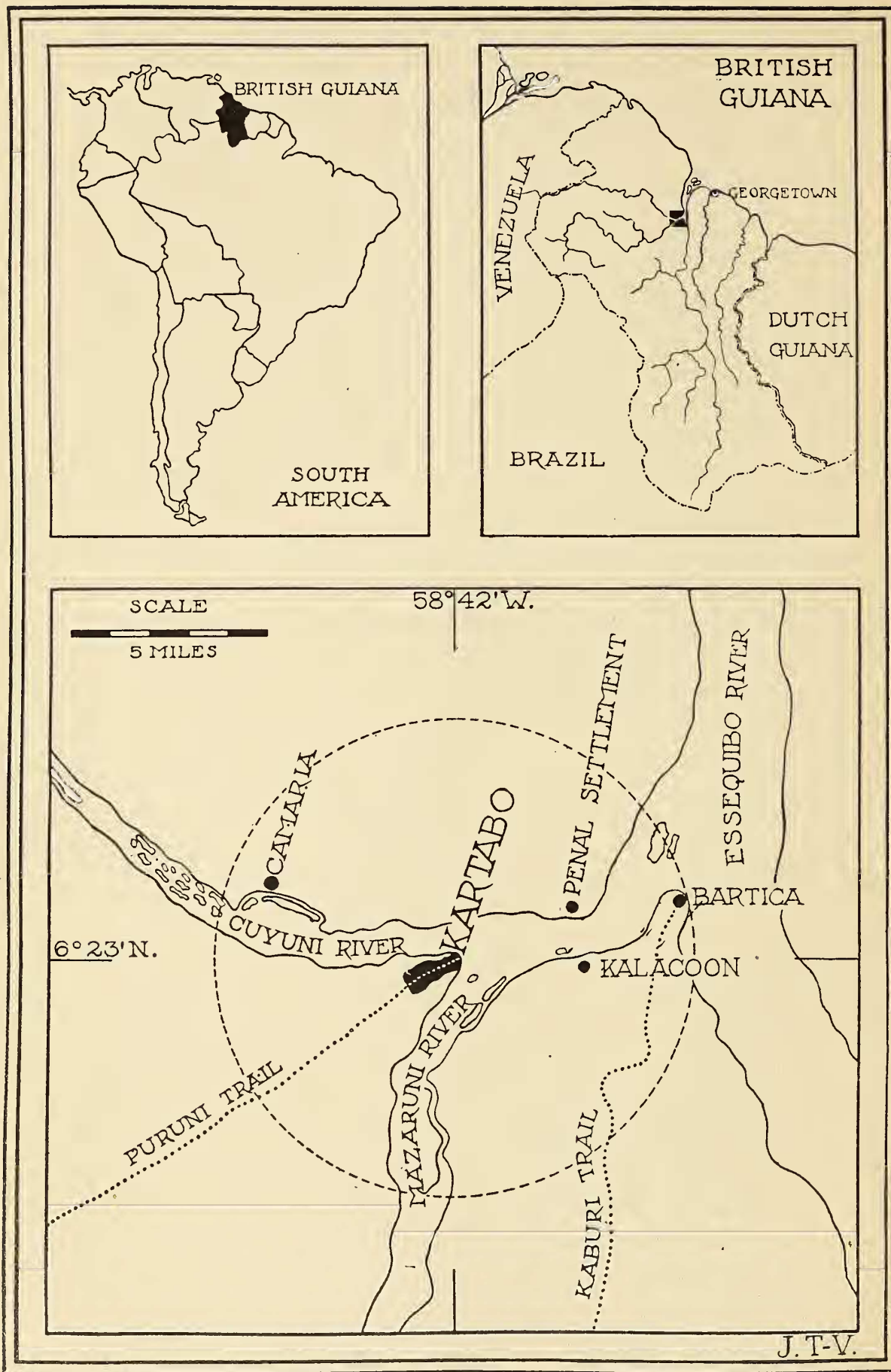


Plate A. British Guiana Tropical Research Station of the New York Zoological Society.
The circle represents a radius of six miles.

STUDIES OF A TROPICAL JUNGLE;¹ ONE QUARTER OF A SQUARE MILE OF JUNGLE AT KARTABO, BRITISH GUIANA

BY WILLIAM BEEBE

(Plates A, B. Figs. 1-17 incl.)

This study of the environment or ecology of Kartabo is offered as a general survey of the region. Every fact in it is as true and correct as I can make it, but all estimates are underestimates. For example, the number of species of amphibians represents probably three-fourths of the actual autochthonous fauna; the mammals observed could certainly in time be increased by twenty-five per cent., and so on. This is in spite of the fact that several of us have spent five seasons of work here, but even in this limited area, the life of the opaque waters, and that under ground, in the lofty treetops and of the night must still hide innumerable forms from us.

This entire contribution outlines the more interesting and significant points of view which have presented themselves while I have been engaged in more specific, definite researches. It is intended as an introduction to the faunal papers which will follow in succeeding numbers of *Zoologica*.

I—GEOGRAPHICAL POSITION

British Guiana, on the north-east coast of South America, is about twice as large as the State of New York. The Essequibo is the largest river of the Colony, and its most important tributary, entering at Bartica, is the Mazaruni. Six miles above this point, the Cuyuni joins the Mazaruni, and at the exact meeting point is Kartabo, the site of the Tropical Research Station of the New York Zoological Society.

The Cuyuni winds for two hundred and fifty miles in a general north-west direction and rises somewhere in the wilderness heart of Venezuela; the Mazaruni, through one of its tributaries, twists and turns through an equal distance of gold and diamond country, and drains the very slopes of the mighty plateau of Roraima, on the Brazilian frontier.

Kartabo, then, is in the north-central part of British Guiana, and its position relative to the three great rivers is such that its exact location is indicated on even the smallest of continental maps. Its position on the earth's surface is 58° 42' West Longitude, and 6° 23' North Latitude.

¹ Contribution, Department of Tropical Research No. 190

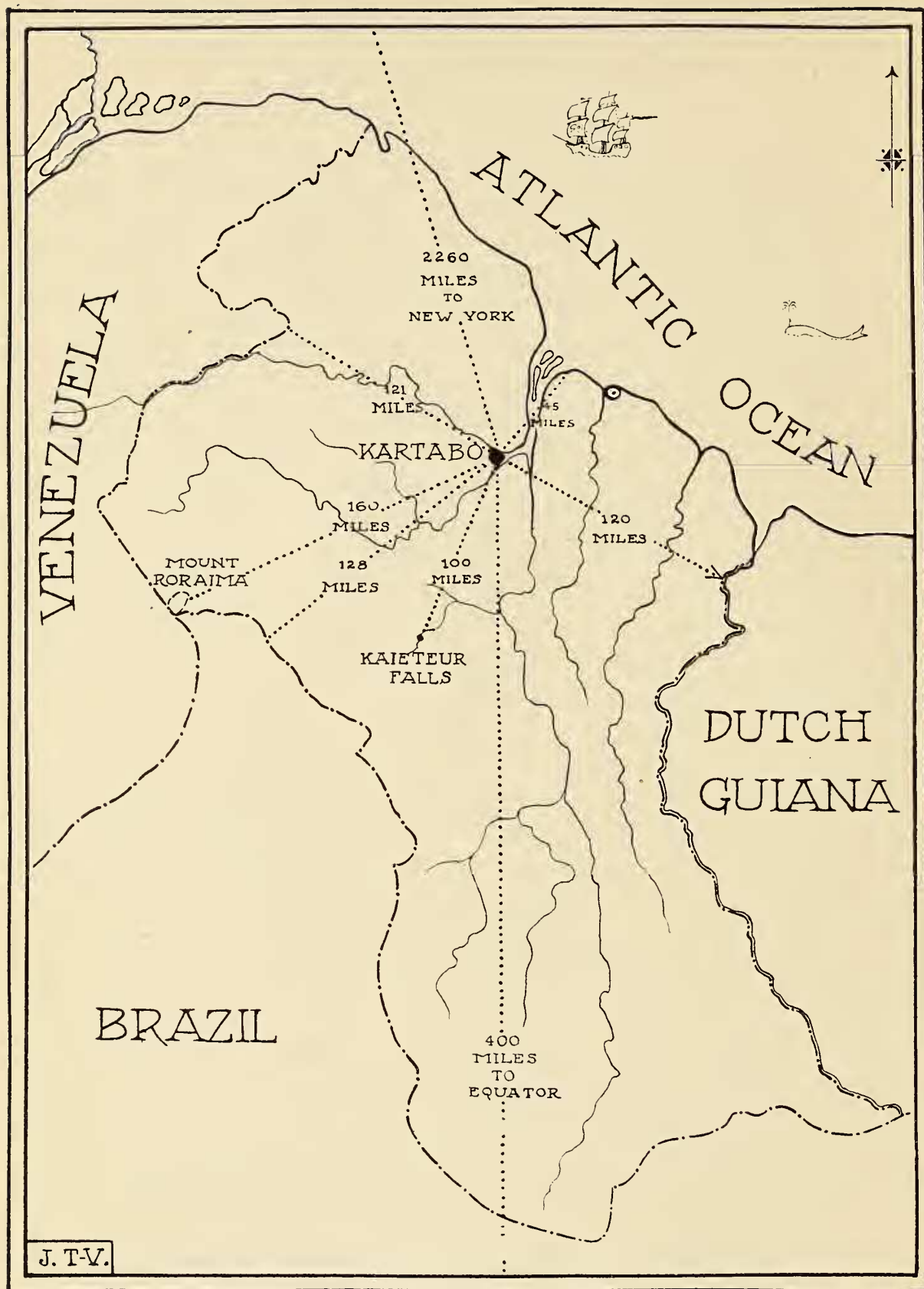


Fig. 1. Orientation Map of Kartabo.
Drawing by John Tee-Van.

The following distance lines of radiation may prove an additional help in the orientation of Kartabo:

The Atlantic Ocean is forty-five miles NNE.

The Dutch Guiana frontier is 120 miles SE.

The Equator is 400 miles S.

Kaieteur Falls are 100 miles SSW.

The Brazilian frontier is 128 miles WSW.

The plateau of Roraima is 160 miles WSW.

The Venezuelan frontier is 121 miles WNW.

New York City is 2200 miles NNW.

As may be seen by the accompanying map, a circle with a six mile radius from Kartabo includes Bartica and the banks of the Essequibo, together with the Mazaruni and the Cuyuni up to their first falls and rapids.

The general research work has been carried on within the black area at Kartabo. *Unless otherwise stated, the following account of this region, and the various articles which will follow in future numbers of Zoologica, dealing with more definite, intensive researches, refer altogether to this tract of land and water, measuring less than two thousand by four thousand feet, at the very point of juncture of the Cuyuni and Mazaruni Rivers—an area one-quarter the size of Central Park in New York City, or, to use a less local simile, a square of land measuring ten average city blocks on each of the four sides.*

This limited field of intensive research is the most important factor in the work carried on at the Station, and presents tropical abundance of life with a vividness which transcends any generalizations or statements based on less definite grounds.

II—METEOROLOGICAL CONDITIONS

Kartabo, British Guiana

Introduction

Accurate records of weather conditions have been kept for many years at His Majesty's Penal Settlement, three miles N. E. by E. from Kartabo, on the north shore of the Mazaruni River, the station being fitted up as a Normal Climatological Station of the Second Order of the International Classification. Records of rainfall are taken at The Hills Plantation, three-quarters of a mile from Kala-coon, the first home of the Tropical Research Station. The Hills Plantation is situated on the south shore of the Mazaruni River, directly opposite the Penal Settlement.

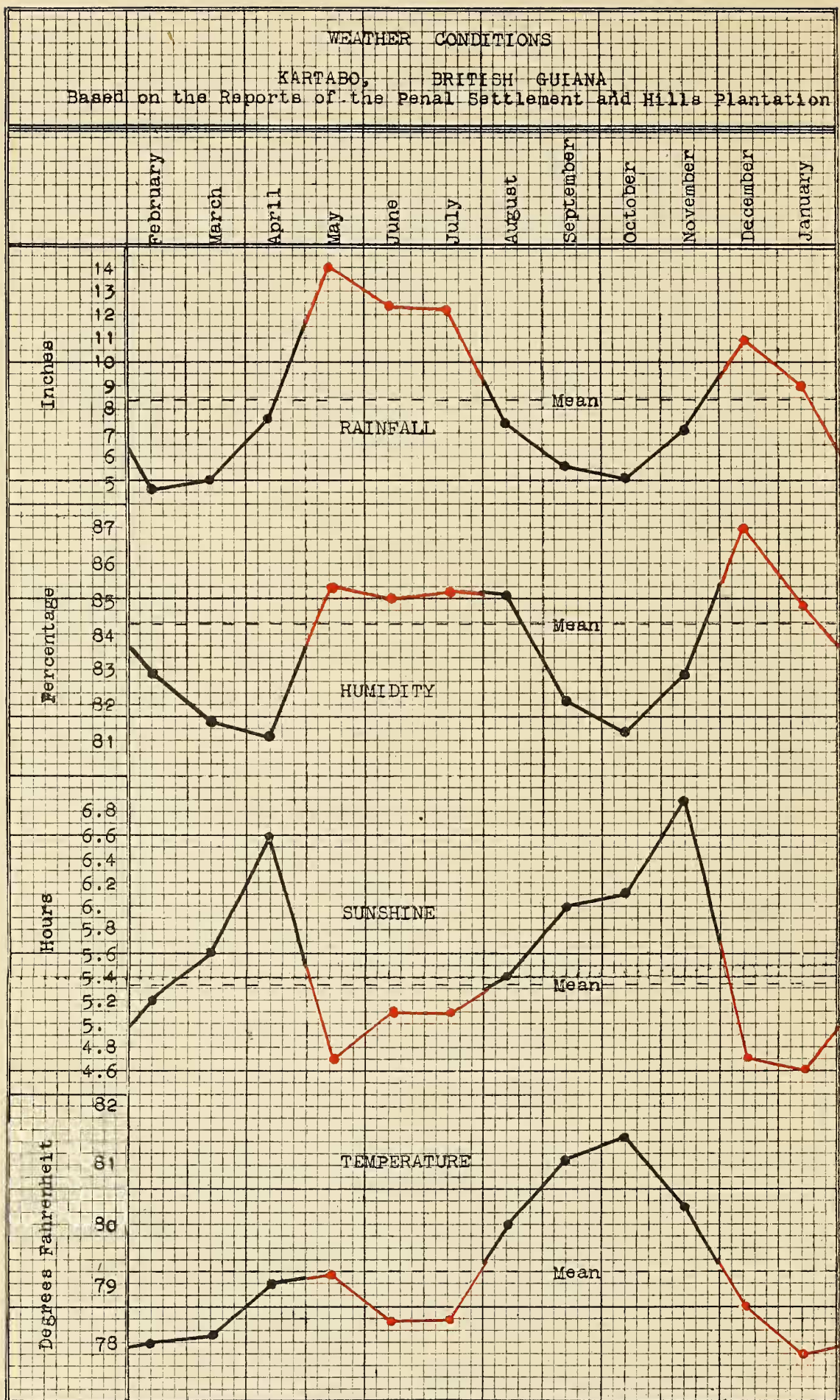


Fig. 2. Variations of weather conditions, Kartabo, British Guiana.

Thus, the two stations, Penal Settlement and The Hills Plan-tation, form the base of the triangle of which Kartabo is the apex. Both places are approximately three miles down river from the Station at Kartabo, and are separated from each other by about three-quarters of a mile.

The reports of these two stations may be taken as representing the weather conditions of Kartabo, and the immediate vicinity, some records extending back twenty years. The following state-ments and charts are entirely based upon the published and un-published records of observations of these climatological stations.

Seasons

Although the beginning and ending of the seasons cannot be stated in exact terms of weeks or days, the following four divisions are recognized as distinct:—

- Short Dry Season—February, March, April.
- Long Wet Season—May, June, July.
- Long Dry Season—August, September, October, November.
- Short Wet Season—December, January.

Adopting these seasons, the rainfall in inches and percentage is given in the following tables:—

Seasons			
Number of Inches and Percentage of Yearly Rainfall			
Short Dry Season	17.05 Inches	16.8	per cent.
Long Wet Season	38.84 “	38.4	“ “
Long Dry Season	25.27 “	25.2	“ “
Short Wet Season	19.81 “	19.6	“ “

Adding the rainy and dry seasons together as single seasons we have the following figures:—

Rainy Seasons	58.65 Inches	58.0	per cent.
Dry Seasons	42.32 “	42.0	“ “

Roughly speaking, three-fifths of the rains are to be found distributed through the five months assigned to the rainy seasons, and the other two-fifths to the seven months of the dry seasons.

This gives an average of 6.04 inches rainfall for the dry months, and 11.73 inches for the wet months.

Rainfall

The average annual rainfall is 100.53 inches. The months average as follows:—

February.....	4.55 inches
March.....	4.94 “
April.....	7.56 “
May.....	14.00 “
June.....	12.44 “
July.....	12.40 “
August.....	7.40 “
September.....	5.56 “
October.....	5.19 “
November.....	7.11 “
December.....	10.93 “
January.....	8.87 “

The list of months given their position according to greatest rainfall becomes:—

May	April
June	August
July	November
December	September
January	October
	March
	February

The available data, as to the number of days upon which rain falls, show an annual average of two hundred and nineteen days or fifty-nine per cent. of the whole year.

During 1920, May and June each had twenty-seven days upon which rain fell, while February, the lowest month, had six days. The highest recorded annual rainfall is 117.75 inches in 1918, and the lowest 77.11 inches in 1911. The highest rainfall for a single month was in May, 1918, 22.34 inches, and the lowest occurred during February, 1912, a year of drought, and was .03 inches.

Humidity

The available records for humidity show observations taken three times a day, at 7:00 A.M., 1:00 P.M. and 6:00 P.M.

The following table gives the mean of these observations:—

7:00 A.M.....	90.9	per cent.
1:00 P.M.....	79.0	“ “
6:00 P.M.....	82.2	“ “
Average.....	84.2	“ “

The following table gives the average of the humidity by months:—

February.....	82.9	per cent.
March.....	81.5	“ “
April.....	81.1	“ “
May.....	85.3	“ “
June.....	85.0	“ “
July.....	85.2	“ “
August.....	85.1	“ “
September.....	82.1	“ “
October.....	81.2	“ “
November.....	82.9	“ “
December.....	87.0	“ “
January.....	84.8	“ “
Yearly average.....	84.2	“ “

Sunshine

Available records for sunshine show the following monthly averages:—

February.....	5.5	hours
March.....	4.3	“
April.....	5.1	“
May.....	4.0	“
June.....	5.2	“
July.....	4.2	“
August.....	6.2	“
September.....	6.8	“
October.....	6.7	“
November.....	6.3	“
December.....	5.5	“
January.....	4.6	“
Average daily sunshine.....	5.3	“

The maximum amount of sunshine for a single day was 11.6 hours on July 30, 1920.

Temperature

Available records of average shade temperature are as follows:—

February	78.0°	Fahrenheit
March	78.1°	“
April	79.0°	“
May	79.2°	“
June	78.4°	“
July	78.4°	“
August	80.0°	“
September	81.1°	“
October	81.5°	“
November	80.3°	“
December	78.6°	“
January	77.8°	“
Average shade temperature	79.2°	“

Placing these months in order, lowest temperatures first, we have the following list:—

January	April
February	May
March	August
June	November
July	September
December	October

The mean, maximum and minimum shade temperatures are as follows:—

		Fahrenheit	
February	82.8°	maximum	73.3° minimum
March	83.2°	“	73.1° “
April	83.8°	“	74.2° “
May	83.2°	“	75.1° “
June	82.8°	“	74.1° “
July	83.3°	“	74.0° “
August	85.0°	“	75.2° “
September	86.5°	“	75.5° “
October	85.2°	“	75.6° “
November	85.9°	“	74.8° “
December	83.5°	“	73.8° “
January	82.5°	“	73.2° “
Yearly average	83.9°	“	74.3° “

Wind

The Station and the research area at Kartabo are located upon an open expanse of four miles of water facing almost due east, so that full advantage is gained from the trade winds, which blow prevailingly from the east, with northeast winds a close second. These breezes from the sea, forty-five miles away, blow almost steadily during the day throughout most of the year, while during January, February and March they continue through much of the night as well.

Occasionally, during the rainy seasons, the wind blows for a short time from the continental side, southeast or even south, and brings with it the heaviest falls of rain.

The wind is remarkably even throughout the year, as shown by the accompanying tables, and varies from "Gentle" to "Fresh" with very few gales and no hurricanes.

Moderately severe thunder storms occur now and then, especially during the changes in the rainy seasons.

The table below gives the average for observation taken upon the force of the wind three times daily:—

February.....	3.5	miles	per	hour
March.....	3.3	"	"	"
April.....	2.7	"	"	"
May.....	2.5	"	"	"
June.....	2.9	"	"	"
July.....	3.1	"	"	"
August.....	3.7	"	"	"
September.....	3.6	"	"	"
October.....	3.8	"	"	"
November.....	3.2	"	"	"
December.....	3.1	"	"	"
January.....	3.6	"	"	"

Summary

Seasons *Two Dry Seasons* occupying seven months of the year, February, March, April, and August, September, October, November; within which two-fifths of the rains fall.

Two Wet Seasons occupying five months of the year, May, June, July, and December, January; within which three-fifths of the rains fall.

In ecological researches at Kartabo, the more natural method is followed of beginning the year with February, the first month of the Short Dry Season.

Rainfall	Average, 100.53 inches (annual). Heaviest—May, followed in order by June, July, December, January. Lowest—March, February.
Humidity	Average, 84.2 per cent. Average 7:00 A.M., 90.9 per cent. 1:00 P.M., 79. “ “ 6:00 P.M., 82.2 “ “ Month of greatest humidity—December. Month of least humidity—April.
Sunshine	Average, 5.3 hours daily. Greatest sunshine—November, April. Least sunshine—January, December, May.
Temperature	Average, shade temperature, 79.2° Fahrenheit. Coolest months—January, February. Warmest months—September, October.
Wind	Prevailing Direction— <i>East to Northeast</i> . Average rate of speed—3.25 miles per hour.

Meteorology of the Coast-lands and the Far Interior Compared with Kartabo

Along the flat, alluvial coastlands, records of weather conditions are taken at many places, the most important meteorological weather station in the Colony being situated at Georgetown. Rainfall and other records have been taken at this Station since 1846, and the figures used are the averages for the available records of this period. The reports show that “the climate at Georgetown is a very equitable one, and one which . . . varies regularly and equitably.”

In the far interior on the savannah country of the plateau regions, records are taken at Eupekari, and at Dada-nawa, both on the Rupunnuni River. Dada-nawa is situated about two hundred and fifty miles southwest by south from Kartabo, at 2° 49' 25.5''

north latitude, and 59° 29' 29.3'' west longitude. Eupekari is nearer Kartabo, about 195 miles in the same direction as Dada-nawa, and is at approximately 3° 40' north latitude and 59° 18' west longitude.

At Dada-nawa the records show that the rainfall is far less regular than at Kartabo, and that it averages lower than the coast-lands, and much lower than the forested region within which Kartabo is situated. The temperature at the savannah stations also has a greater range, the maximum being higher and the minimum lower than at any of the coast stations.

Meteorology of Kartabo

Compared with that of the Coast-lands and the Far Interior

	Coast Lands	Kartabo	Interior Stations
Rainfall.	94.37 inches	100.53 inches	51.88 inches
Humidity	78.1 per cent.	84.2 per cent.	86.5 per cent.
Temperature. . .	80.4° Fahr.	79.2° Fahr.	83.1° Fahr.

III—GEOLOGY

The Colony of British Guiana may be divided into three transverse zones: First, the narrow, flat, alluvial coast-land much of which is actually below high tide level, and which never exceeds an elevation of ten feet, and along the Essequibo River reaches about twenty miles inland. Second, a zone of sedentary sand and clay, in which Kartabo is situated. This lies back of the low coastal region, and extends clear across the Colony. The origin of the sand and kaolin is given later. This zone is one of low elevation, from fifteen to two hundred feet, and is of greatly varying width. The country is undulating and is generally covered with high, tropical rain forest. Third, the mountain zone consisting of undulating plateaus, rising successively from one thousand to twenty-five hundred feet, occasionally cut into deep gorges as the eight hundred and ten foot fall of Kaieteur, and culminating in the flat-topped plateau mountain of Roraima, five thousand feet above the surrounding country and eighty-six hundred feet above the sea.

Rocks, Minerals and Soil

At low tide, a considerable extent of rock appears at Kartabo

Point, extending along the shore from B₆ south to C₅. Again farther south at Boom-boom Point, I₁ and I₂, and J₁ and J there is a great massive outcropping. Of these rocks Sir John Harrison writes that they "consist principally of grey granite but pegmatite or giant-granite is present in abundance. In places good specimens of graphic granite may be obtained. Mica is present in the giant-granite, sometimes in large plates, while here and there red garnets are fairly abundant in the pegmatite veins. A little to the westward the medium-textured light-gray granite is seen with a glistening darker-colored, fine-grained rock apparently intrusive in it. Both are traversed by veins of coarse pegmatite, which in places contain garnets. The fine-grained rock is seen, on microscopic examination, not to be an intrusive igneous rock, but a clastic sedimentary rock caught up in, and intensely metamorphosed by, the granite."

The gray granite almost at the very door of the Research Station represents the basic foundation of earth structure, the very skeleton of the planet, fashioned in planetary flame, upon which the other rocks rest, over which the rivers flow, and standing as a contrast to the evanescent plant and animal life existing upon its great masses.

The granite at Kartabo and near-by points is the largest outcropping in the Colony. Harrison describes it in detail as containing large irregular plates of orthoclase or potash felspar, in places with albite or milky-white felspar, numerous small plates of microcline and abundant ones of oligoclase. The felspars contain some inclusions of small granules of epidote and minute flakes of secondary muscovite, and irregular patches of quartz. The micas are in the form of large plates of muscovite and flakes and wisps of greenish biotite. A few grains of sphene, rarely minute crystals of zircon and some granules of iron-ore are present.

The dominant inorganic character of the research area consists of sands and clays, residual deposits in distinct contrast to the fluvio-marine deposits of the alluvial coastal zone. The rapidity of disintegration of exposed granite in this region is almost unbelievable, breaking down into deposits which are distinguished from finely divided fluvio-marine matter by the relatively great abundance of heavy minerals in the former. Aplite, granite, pegmatite, quartz-porphyrries, the more acidic granitites, and the gneisses and schists derived from them give rise to more or less sandy kaolins and pipeclays, varying in color from white to cream. The beach in

front of the Station consists of white quartz sand overlying firm deposits of creamy-white kaolin. The rocky bank back of this is seen in the process of actual erosion and disintegration. In these deposits from metamorphosed granites muscovite is present in abundance together with small crystalline grains of corundum. In addition to these tourmaline, topaz, beryl, garnet and spinel are found. At Kartabo the inorganic factor in the ecology is a relatively unimportant one, but within short distances metals and minerals are of the utmost importance. Thirty-five miles to the southeast thousands of tons of kaolin have been mined, for the bauxite derivative of the contained alumina; in the Kartabo sand are occasional flakes of gold, while fifty miles to the west paying gold diggings begin, culminating in a spot like Omai, sixty-five miles to the south where from an area of sixty acres over ninety-five thousand ounces of gold have been taken. The diamond fields are no farther away.

At first only a few stray stones were found, but today the diamond-bearing area includes three thousand eight hundred square miles. During the first twelve months of 1923, 1,141,425 diamonds were found, aggregating 214,475 carats. The largest stone weighed $48 \frac{1}{8}$ carats and was found on the right bank of the Kurupung.

Gold mining began in the Cuyuni in 1863, but no great amount was taken out until 1886. The largest nugget found weighed 28 oz. 10 dwts.

Earthquakes

Earthquakes are felt now and then, usually slight and transitory occasionally more severe and with appreciable effects. One of these occurred on May 10th, 1922 at 3:00 A.M., lasting about twenty seconds, travelling from East to West. The laboratory was severely shaken, trees were loosened, and large amounts of earth slipped down along steep banks of the river and inland gullies.

During seven years, six rather severe shocks have been recorded:—

March 26, 1915.....12:25 A.M.

March 29, 1915..... 7:00 P.M.

February 24, 1918..... 7:20 P.M.

May 31, 1921..... 4:30 to 5:00 A.M. Two shocks.

May 10, 1922..... 3:00 A.M.

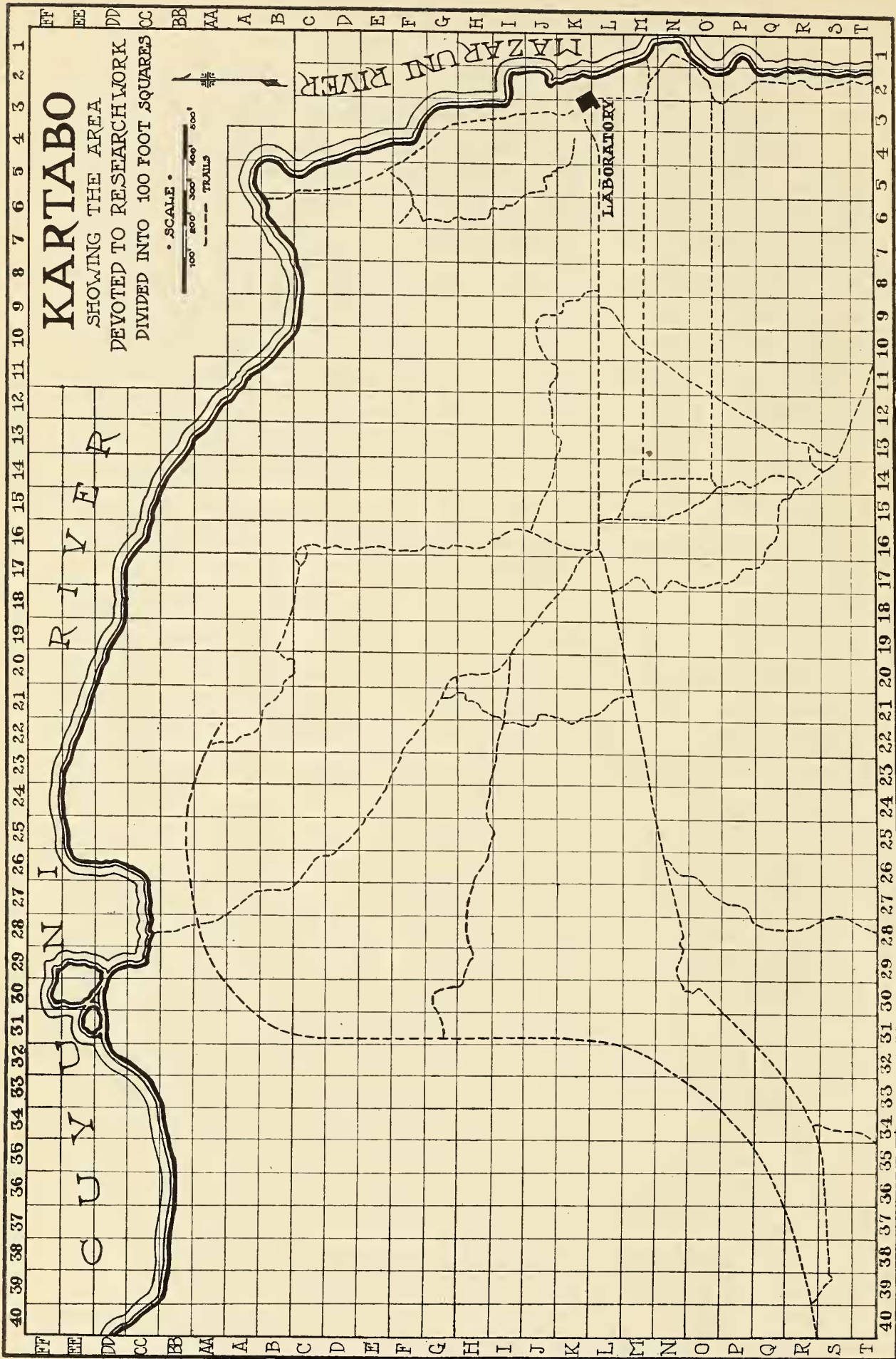


Plate B. Area devoted to research at Kartabo.
 Drawing by John Teo-Van.

IV—PHYSICAL CHARACTER

Kartabo, British Guiana

Within the approximately quarter of a square mile devoted to research work at the Tropical Research Station, the average height of the land mass may be placed at between thirty and fifty feet above the mean tides.

Along the shore of the Mazaruni River, immediately surrounding the laboratory, the land is flat, averaging about five to fifteen feet above the mean level of the river. Three hundred feet west of the laboratory, and about four hundred feet from the river, the land rises sharply, forming a rounded hill about eighty feet in height, two to three hundred feet through at the base; continuing westward, expanding laterally, until in the western end of the research area it becomes over a third of a mile wide. The northern aspect slopes abruptly downward, while the slope on the southern side is very gradual, occupying about two-thirds of the width of the entire hill. This hill forms the beginning of the divide between the Mazaruni and Cuyuni Rivers, extending southwestward, becoming higher and joining the southernmost extension of the Oko Mountains, thirty miles away.

In the northwestern portion of the research area the hill nearly meets the shore of the Cuyuni River, while to the north and north-east are found swamps and moist lowlands. Southward of the hill rolling lowlands predominate, and swamps are fewer in number and less in extent. The majority of the swamps are formed by the rains, and rarely by springs or underground seepage of water.

Tidal Area and Shore

The shore area of the rivers influenced by tides is extensive and varied, occupying approximately six thousand linear feet, divided into the following:—

Rocks	300 feet
Sandbeaches	650 feet
Shore steep, edge of jungle, tree roots merging with tidal area	1200 feet
Shallow, mud and sand-bottomed flats	3850 feet

On the northern boundary of the research area from BB₃₆ to DD₃₂ on the Cuyuni River, the shore is shallow, with many rocks

scattered about on the mud and sand of the bottom. Jungle trees come to the edge of the water, their roots often forming an intimate portion of the tidal area,—the water lapping over many feet of their buttressed supports.

From DD₃₂ eastward to about EE₂₂, the area including the two Cuyuni Islands and Emerson Bay, the tidal area is small and the shore drops away rapidly. Trees come to the edge of the water, but mangroves and a consequent shallow shore are not present, due mainly to many swirling whirlpools within the bay, and to the currents of the Cuyuni on the outer portions, which at this point are very swift. There is much rock to be found on the shores of the two islands, especially about the easternmost larger one. This rock is continuous with a line of rocks which project northward for two to three hundred feet, partially exposed at low water. The remainder of the Cuyuni shore from EE₂₂ to the easternmost portion of B₇ is shallow and shelves slowly, most of the bank being covered with mangroves.

The point of land which marks the dividing line between the Cuyuni and Mazaruni Rivers has an extremely small tidal area, and is formed of rocks descending sharply into deep water.

Passing around the rocks at the point of land to the Mazaruni side of the research area, the tidal space is first formed of coarse whitish-yellow sand (B₅ to E₄), shelving rapidly on its northern end, and merging to the south with shallow mud and sand bottom banks covered with mangroves; this shore descends very slowly into the deeper portions of the Mazaruni (E₄ to H₃). A large outcropping of gray granite forms the next portion of the shore, bare and forbidding in appearance (I₂, J₂), with many sharp, jagged pieces on the mud and sand bottom, which is continuous with the remainder of the shore.

To the south of these rocks (J₂ to M₁) is the beautiful, three hundred foot long sand beach, which extends in front of the laboratory. This beach is mainly formed by the breaking down of the fifteen foot cliff-like bank of clay and sand in front of the station. It is continuous with the great bank of coarse, yellowish-white sand which extends down river for over three-quarters of a mile from the laboratory. This bank has been formed by the constant swirls and eddies caused by the meeting of the two great rivers. During very low tides, it is possible to walk down stream for over half a mile, without finding more than two feet and in many places only six inches of water.

Below the sand bank another group of gray granite rocks are found (N_1), followed by a steep, yellow clay bank (southernmost part of N_1 and northernmost part of O_1), fifteen feet high extending for about fifty feet. This borders on shallow sand and mud flats which abutt on jungle trees and tree roots, and extends to the southeastern end of the area devoted to research work.

Water

The area at Kartabo devoted to research is bounded on the north by the Cuyuni River, which at this point is not quite half a mile wide (2500 feet), and on the east by the Mazaruni River, whose nearest point on the opposite shore is nearly a mile and a quarter away (6350 feet).

The tides on these huge rivers are swift, the downward current running from one to three miles an hour. The average rise and fall amounts to from six to six and a half feet. During seasons of high water at full moon tides the waters are often six to eight feet higher than the usual high tides. Five miles above Kartabo the tides in both rivers end, as at that point the first rapids are found.

At Georgetown and at the mouth of the Essequibo, forty-five miles downstream from Kartabo, the tides average about two and a half hours earlier than they do at the station.

The time occupied in rising and falling is influenced greatly by the amount of water flowing down from the upper reaches of the rivers. The difference sometimes varies to the extent of a falling tide of nine hours and a rising tide of two and one half hours.

The color of the water is a pale brown, mainly caused by the stains derived from the leaves of the wallaba tree (*Eperua falcata* Aubl.). At 8:30 A.M. with the sky half covered with clouds, the color in the shade approaches nearest to olive-brown (Ridgway). But the influences of shade and depth are such that the water appears to have a greenish tinge instead of reddish. Lowering a white disk six inches in diameter into the water, the color is quite yellowish at the surface, becoming browner farther down, and near the point at which it disappears acquires a distinct orange tone.

Experiments at 8:30 A.M. give the following color values, as compared with Ridgway's "Color Standards and Nomenclature," observed over a six inch white disk at different levels:—

Surface. White

1 inch.....	Cartridge Buff
2 inches.....	Colonial Buff
3 inches.....	Deep Colonial Buff
4 inches.....	Warm Buff
5 inches.....	Antimony Yellow
6 inches.....	Dull Capucine Orange
12 inches.....	Zinc Orange
15 inches.....	Vinaceous Fawn
18 inches.....	Russet Vinaceous

From eighteen inches downward the colors become darker and darker, and at twenty-five inches the disk disappears from view. This depth of twenty-five inches at which the disk disappears is to a great extent independent of the position and intensity of light from the sun, and is brought about almost entirely by the amount of stains and coloring matter held in suspension by the water. Experiments with the sun directly overhead, or at an angle of 30 to 35 degrees give the same result,—a blocking out of the disk at twenty-five inches.

Occasionally during heavy rains about the upper portions of the rivers, quantities of brownish yellow coloring matter, in appearance much like the yellow-brown Amazon mud carried in suspension by the sea along the coast of Guiana, is brought down. During the second and third weeks of May, 1922, the waters of the Cuyuni were deep brownish-yellow, quite opaque, so much so that one's hand disappeared from view six inches below the surface. The difference between the clear waters of the Mazaruni and the colored water of the Cuyuni was especially noticeable at Kartabo.

On the sand beach in front of Kartabo, the temperature of the water below the surface and near the bottom averages 79–80 degrees Fahrenheit.

Within the area devoted to research there are a few small streams, which disappear to a great extent during the dry season. At the northwestern portion of the research area is a single larger creek about ten feet across.

V—THE FLORA OF KARTABO

The flora of Kartabo has been studied by no competent general botanist, and in this résumé I have attempted nothing but an indication of the more conspicuous and abundant growths, particularly

those which possess an important relationship with members of the vertebrate fauna, either in the way of food, homes or media of support and progress.

Fluviatile

Blue-green, red and brown algae and diatoms are abundant but no collections have been made of them. Very remarkable purple algae have been found in the stomachs of puffers but not observed elsewhere. Both the two- and three-toed sloths have the well-known peculiar green algae growing on the dorsal hairs.

Littoral

The littoral flora is sharply delimited to between tide marks. Where the current is swift near shore, these forms are almost hidden by overhanging vines and lianas, dependent from the high jungle trees which crowd down to the very water. Along sandy and sloping muddy shores they are spread out, but even in such places do not extend more than a few yards from the high tide mark. Specific associations are well marked in the littoral flora, solid cultures of mangroves, sedge, mucka-mucka and others.

The mangroves, *Rhizophora mangle* Linné, find root-hold in certain definite areas of the gently sloping mud-flats, feeling their way far out, with long steps, foliage held high out of reach of the water. They are in no sense shore builders, they do not attempt to stay the tide, but allow it freedom to wash back and forth.

Back of them, on firm mud and sand, the tall graceful sedges live out their half aquatic, half aerial lives. The two dominant species are the White-plumed Sedge, *Eleocharis geniculata* R. Br., and the Starry Sedge, *Cyperus* sp. The former are gigantic in favorable spots, with their triangular, forest-green stems reaching up twelve feet, while the latter present lowlier clumps topped with the fluffy white catkins. This one grows in denser clumps and is a better land holder, but the roots do most of the work. The stems survive the wash of waves by their pliability, giving instead of breaking.

In spots where the current is not too swift or waves too violent, appear rank upon rank of that aroid lily with the incongruous name of Mucka-Mucka, *Montrichardia arborescens* (Linné) Schott. The tall stout stem sends off great arrow-heads of leaves, and occasionally



Fig. 3. Mangrove beach at Kartabo.
Photograph by John Tee-Van.

a large white calla-like lily and later the pineapple fruit. Here and there are small patches of Horse Tails, *Equisetum*, hinting of epochs long since past. In 1919, these were confined to an area of not more than two square yards. Two years later this particular section had been washed away and I have found no further trace of these plants.

Clustering around the sedge clumps, like dug-in outposts, are the low, white-flowered *Diodia*, creeping along the sand and helping the coarse grasses to cling to the shifting grains. The most conspicuous flower stalks of the fore-shore are the tall Shore Gentians, *Coutoubea spicata* Aubl., which hold up their racemes of pinkish-white flowers well below high tide level. Their roots go deep and after a severe storm they seem to suffer less than some of the stronger growths.

One of the most valuable shore-binders is the rush-like herb, *Xyris tenella* Kunth. Hundreds of these little grassy-leaved plants take root beneath the mangroves and their roots mat together while their tall, clubbed-top stems rise bravely and expand tiny yellow blooms. With them occur the straggly, jointed stems with the inconspicuous pea-like flowers of *Vandellia difusa* Linné.

Very numerous, but so tiny and fragile that only close examination reveals their existence, are Utricularias bearing minute yellow blossoms.

On beaches of pure sand, fronting disintegrating, soil-covered banks, the plant association is of another character, all uniting to hold fast to as much as possible of the granitic talus which now and then slides down in sandy avalanches. Such is the beach directly in front of the laboratory.

Every inch of the precipitous bank which offers foothold is covered with representatives of the clearing flora,—the pink and white Mazaruni primroses, *Sipanea pratensis* Aubl., being the only bright color note.

At the foot of the bank the force of the tides is felt and the plants are no longer the gentle growths of a summer meadow, but must be sufficiently virile to hold their position against water and wind. As opposed to the mangrove zone, the dominant plants here are grasses. Close to the bank clumps of great, coarse beach grass, *Panicum* sp., sprout, with stems bent, but measuring ten feet in length. Farther down shore are creeping grasses, *Courmelina longicaulis* Jacq., whose stems seek safety by allowing themselves to become half buried in the sand, with leaf tips coming up for breath.

These are perhaps the best sand-binders, and given half a chance will form a mat of their interlacing stems, which holds fast to the grains. Smaller clumps mimic the larger, and *Sporobolus* succeeds by developing strong roots but soft pliable stems, which, even in the air, lie prostrate, like green tresses combed back by the touch of the last wave, until the next incoming tide washes them to and fro like the softest algae. In surprisingly exposed places the curious little clover-like, purple-flowered *Desmodium* stands bravely in low, compact bunches, while *Kyllinga* with its small white flowers creeps feebly a few inches from its roots. These, with a few isolated plants of sedge, form the outliers of the plant world, in the ever shifting zone between solid land and the impassable barrier of low tide.

The mangroves cheat the jungle and find their light and air far beyond the competition of the great moras and purpleheart, where, although thriving a few yards away, these mighty trees cannot follow. Like most get-rich-quick schemes, however, the mangroves yield to the law of compensation, and every branch, twig and root has its parasites and epiphytes. Bromeliads, in serried rows and clusters, are so abundant that they sometimes break down their very support. The roots above low water are coated with moss and lichens, while the branches are often put under terrific strain by burdens of heavy vines, such as *Souroubea guianensis* Aubl., and its interesting relations, several species of *Marcgravia*. Even the topmost twigs are not free from invasion. While the mangroves' own flowers are small and inconspicuous, the epiphytic orchids are numerous and beautiful, and when they are in full flower their odor and color make it a delight to canoe through the arching roots. The most abundant forms are *Epidendrum fragrans* Sw., *Epidendrum nocturnum* Jacq., and *Diacrium bicornutum* (Hooker) Benth.

While the actual flora of the tidal area is limited and fixed, yet this zone offers one of the most fertile fields for another phase of botany,—the flotsam and jetsam of the river current. Every receding tide leaves a host of stranded nuts and seeds. As I once wrote of this same current farther down stream, "There were spheres and kidney-shapes, half-circles and crescents, heads of little old men and pods like scimitars and others like boomerangs. Some were dull, others polished and varnished. They were red and green, brown and pink and mauve and a few gorgeous ones shaded from salmon into the most brilliant orange and yellow. Most

were as lifeless in appearance as empty shells but there were many with the tiny root and natal leaves sprouting hopefully through a chink."² And so along the line of the highest tides scores of small plants are often found sprouting, which have drifted down many miles from hinterland jungles.

Jungle

Unless artificially altered by man, the littoral flora merges directly and abruptly with that of the jungle. The outermost trees may be a mangrove with strong buttressed trunk, and little to indicate its spidery, amphibious character farther riverward. Close alongside is a tall jungle tree, perhaps a mora, which reaches up a hundred and fifty feet, or a purple-heart almost as tall.

At Kartabo some of the river jungle is swampy, with palms as a dominant association, mingled with hard and soft wood trees. Passing to dry or higher ground, we find the typical rain forest of Eastern South America. It is impossible to describe in accurate detail, for every square yard, every dense thicket or open glade has a character of its own. In the most luxuriant primeval jungle, the great trees rise at considerable distances from each other, with trunks straight as plummets, and often quite bare of branches for one hundred feet. They support such a dense canopy of their own and of parasitic foliage that there is always a dimness as of twilight beneath. The undergrowth is scanty and low, and the midjungle is broken only by occasional lianas or aerial rootlets, all of which are as straight as the tree-trunks.

Where plantations of the Dutch once existed in the far distant past, or more recent clearings made by the Indians for cassava, the new growth never quite regains its maximum development. In these changed conditions, while there are very many large, very tall trees, yet there is not the unbroken aspect of the roof of the jungle, and the undergrowth instantly reflects this in its more lush character, both in abundance of aspiring saplings and in lesser ferns and shrubs. Jungle of these and of intermediate types is found in the research area.

In swampy areas *Ichnosiphon* grows luxuriantly, tall, smooth, reed-like green stems, with a burst of leaves at the summit. Ant-birds sometimes build in the heart of the foliage head, and the split

² Jungle Peace, p. 75



Fig. 4. Palm swamp near the Research Station.
Photograph by John Tee-Van.

stems are used by the Indians in basket making. Comacuballi lianas climb trees and palms and thrust out masses of red berries beloved of birds. In these places wild ginger, escaped from long forgotten plantations, sends its six to twelve foot leaves up from compact clumps, and *Heliconias* run riot.

Even in low jungle one can always see through the undergrowth for ten to thirty yards, and while interlacing vines sometimes make going difficult, usually it is only fallen trees and branches which hinder one. Thorns are rare, but when they do occur, as on the climbing palms, it is useless to force one's way. They must be patiently pushed aside or cut away. The jungle floor is never bare. One may tramp for hours and never know whether sand or black mold is the substratum underfoot. There is always a thick mat of fallen leaves and twigs, sometimes an inch or two, sometimes a foot deep. Digging down we find these gradually altering from the leaf which has just eddied down, through blackened, half decayed leaves to homogeneous, earthen mold, ready to be drawn up again into living sap. In the dry season the leaves crackle at every step, in the wet they are silent to the foot, and soaked, but always they are present. No thick growth of moss lies underfoot but every inch of twig and branch and trunk is painted and hung with fungi, lichens and moss.

In deep jungle, flowers, up to man height, are not uncommon, but inconspicuous, but fallen petals and blooms are abundant, often having dropped a hundred feet from some obscure vine, not distinguishable from the foliage at that height. Or zones of intense sweetness will indicate flowers which are invisible. If looked for, dozens of inconspicuous greenish blooms will be found low down or springing from the mold, but at the least hint of glade or open trail, color becomes evident, and the sombre jungle loses its meaning.

Color in masses is to be found in the tree-tops when whole trees burst into a solid head of lavender or pink within twenty-four hours, or along the river banks, where hanging vines transform overnight into floral avalanches. Another source of color peculiar to the tropics is the brilliance of new leaves. A Kartabo spring reminds one of the northern woods at the height of autumnal change. This leaf coloring holds even in the dark jungle shade, and here too the pigmented place of flowers is taken by the leaves of caladiums, of *Tontanea* and of *Coccocypselum*, on whose chlorophyll palettes are spread splashes and lines of white, cream, pink and scarlet.

Lichens, fungi and mosses are everywhere. Even in the dry season, they flourish in damp places, while during the rains they rival the flowers of the glades in color, and are of every conceivable form and shape, mimicking on a small scale all the greater growths of shrubs, trees, vines, besides adding such similes as umbrellas, lace-work, and pagodas. As for molds, smuts and rusts on the leaves of jungle growths, a mycologist who spent four days at the Research Station collected three hundred forms in a few trips along the trails.

The importance of this density of vegetable growth covering every inch of dry land, cannot be appraised too highly, no matter what form of organic life we choose for intensive study. It actually brings into existence a new land of organic life,—secondary, pseudo meadows and aerial fields, a hundred feet or more above the solid ground, transferring to these hanging gardens the color and variety of foliage, flower and fruit, as well as specialized animal life of every group, which for our lowly structure and limited senses exists elsewhere only in open clearings.

Jungle Trees from Sixty to One Hundred and Fifty Feet,
Rarely Two Hundred Feet in Height, Found in
the Research Area

Dimorphandra excelsa (Schomb.) Baill.

Mora: One of the tallest of jungle trees, often with enormous buttresses; common close to tide or in swampy places.

Nectandra rodiei Schomb.

Greenheart: Another giant of the tropical rain forest, the most sought for commercial wood; much heavier than water.

Carapa guianensis Aubl.

Crabwood, Guiana Mahogany: Very tall trees, second in value commercially only to greenheart. It is the cheapest Colony timber. Crab-oil is made from the kernel of the fruit.

Pentaclethra macroloba (Willd.) Kuntze.

Trysil: Medium to large timber trees, usually near water; very finely divided foliage, long tasseled flower panicles attracting hosts of insects. In full flower throughout May.

Aspidospermum excelsum Benth.

Paddlewood, Yaruru: Several large trees in the area; stumps of

others show where the Indians have obtained paddles in past years.

Rhizophora mangle Linné.

Mangrove: Forms a pure culture littoral fringe in many places.

Spachea elegans A. Juss.

Pigeon-berry: A tree of medium height thriving both in jungle and clearing, covered in April with a dense mass of paniced blossoms, attracting hosts of insects and birds. A decoction of the bark is an astringent, used by the Indians for dressing cuts.

Inga sp.

Waikey: One of the few soft-wood trees; medium to large, smooth, whitish bark, moderate pointed leaves.

Hevea sp.

Hatteeballi: A tall tree of deep jungle.

Sapium jenmani Hemsl.

Wild Rubber: Grows to very large size; does not die when exposed to direct sunlight by the cutting of surrounding jungle; smooth-barked; the tallest trees develop thick buttresses.

Vochysia tetraphylla DC.

Etaballi: Tall jungle tree, with large bole, slightly roughened or scaly bark, rich, dark green foliage, golden brown wood with silver grain, bursts suddenly into bloom about April 1st, the flowering lasting throughout the month. A second season of less luxuriant blossoming begins August 15th.

Cassia multijuga Rich.

Guana: Tall white-barked tree, finely divided foliage, conspicuous yellow flowers, abundant along river banks and near clearings; very abundant. Height of flowering September 1st to 15th. Exceedingly attractive to insects.

Anacardium rhinocarpus DC.

Wild Cashew, Hoomalgee, Hubudi: Tall tree of deep jungle.

Spondias lutea Linné.

Wild Plum, Hog Plum, Hoobooballi: Tall jungle tree, thriving also in clearings. The yellow, oblong, delicious smelling fruit is eaten by birds, animals, and Indians; bark rough with longitudinal lines, pinnated leaves. Most individuals begin to drop fruit in late February, and continue steadily for four months, the last falling in July.

Other trees, perhaps close by, but fewer in number, begin their season of ripened fruit August 15th and end in November.

Copaifera pubiflora Benth.

Purpleheart: Uncommon, very large jungle tree; one of the tallest in the research area recently fell into the waters of the Mazaruni. It showed three hundred and eighty annular rings. The heart is deep purple or magenta, and is extremely hard; logs free from sapwood are sometimes a yard square.

Piratinera guianensis Aubl.

Letterwood, Snakewood: Chocolate wood with patches of brown and black, like the skin of some snakes; used for canes and small ornamental objects, and by the Indians for bows, although very brittle. The trees are small, full-grown ones being only sixty feet high; once abundant, as indicated by old Dutch reports of cargoes exchanged with the Indians for this wood; now a few small saplings only are left in this locality.

Hymenaea combaril Linné.

Locust, Siniri: Tall, with smooth bark, beautifully banded with red, gray and yellowish, like layers of clay; very finely divided foliage. The wood is orange-red. The Indians make wood-skin canoes from the bark.

Hieronyma laxiflora Muell. Arg.

Suradanni: Deep red wood, cross-grained, good for gun-stocks and canoes. One of the largest trees of the research area jungle is of this species.

Simarupa amara or *officinalis*.

Simarupa, Matchwood Tree: Wood milk-white, soft; one of the tallest trees, projecting high above the surrounding jungle. The only jungle tree we have been able to scale, reaching a height of eighty feet by means of two alternating rows of large spikes driven deep in. The second year a newly established nest of stinging bees made it impossible to climb. Deeply lined bark, well covered with moss and lichens, very finely pinnated foliage; used for boards and match sticks.

Unidentified.

Dalina: A tall forest tree with exceedingly hard wood. Trunk deeply grooved, often looking like a mass of lianas; leaves large and oval.

Cecropia palmata.

Cecropia, Congo Pump, Pumpwood, Wanasuru: Very tall and rapidly growing tree in jungle, also springing up in abandoned cassava fields. Wood light, used for floats. In tall jungle individuals, the base is supported by mangrove-like flying buttresses. Enormous leaves in a complex cyme, rattling together loudly in the slightest breeze. The sole food of three-toed sloths.

Unidentified.

Kurahara: Although producing logs fifty feet long by twenty inches square, and excellent for making furniture, canoes and spars, yet this tall tree is unidentified. The wood is reddish brown and takes a fine polish. In K 14 is a young tree with straight, bare stem and a rounded canopy of leaves, umbrella-like. The leaves form a large palmated cluster on the end of a very long, straight, horizontal stalk, arising directly from the trunk.

Unidentified.

Meerah-wood, Antwood: A very large tree, getting its name from harboring a species of stinging ant.

Unidentified.

Hooroo-wassa: A very large jungle tree, small, short-oval, pinnated leaves, and with small curved bean holding about ten seeds; bark light colored, flaking off in scales, as soft as pine. An enormous one in N 11, supporting masses of very large epiphytes.

Myristica surinamensis Roland.

Dalli: Very rapid growing, soft wood; rare, only one or two trees near laboratory. Trunk tall and straight, whitish, coarse pinnated foliage.

Unidentified.

Wareemeah: Common tall jungle tree. On one, which was cut close to the laboratory, ninety-three species of ants were found by Professor William M. Wheeler. Sprouts come up very quickly from the stump.

Nectandra sp.

Silverballi: Bark silvery white, branches wide spreading in young tree.

Unidentified.

Potchuwee: Tall tree, uncommon.

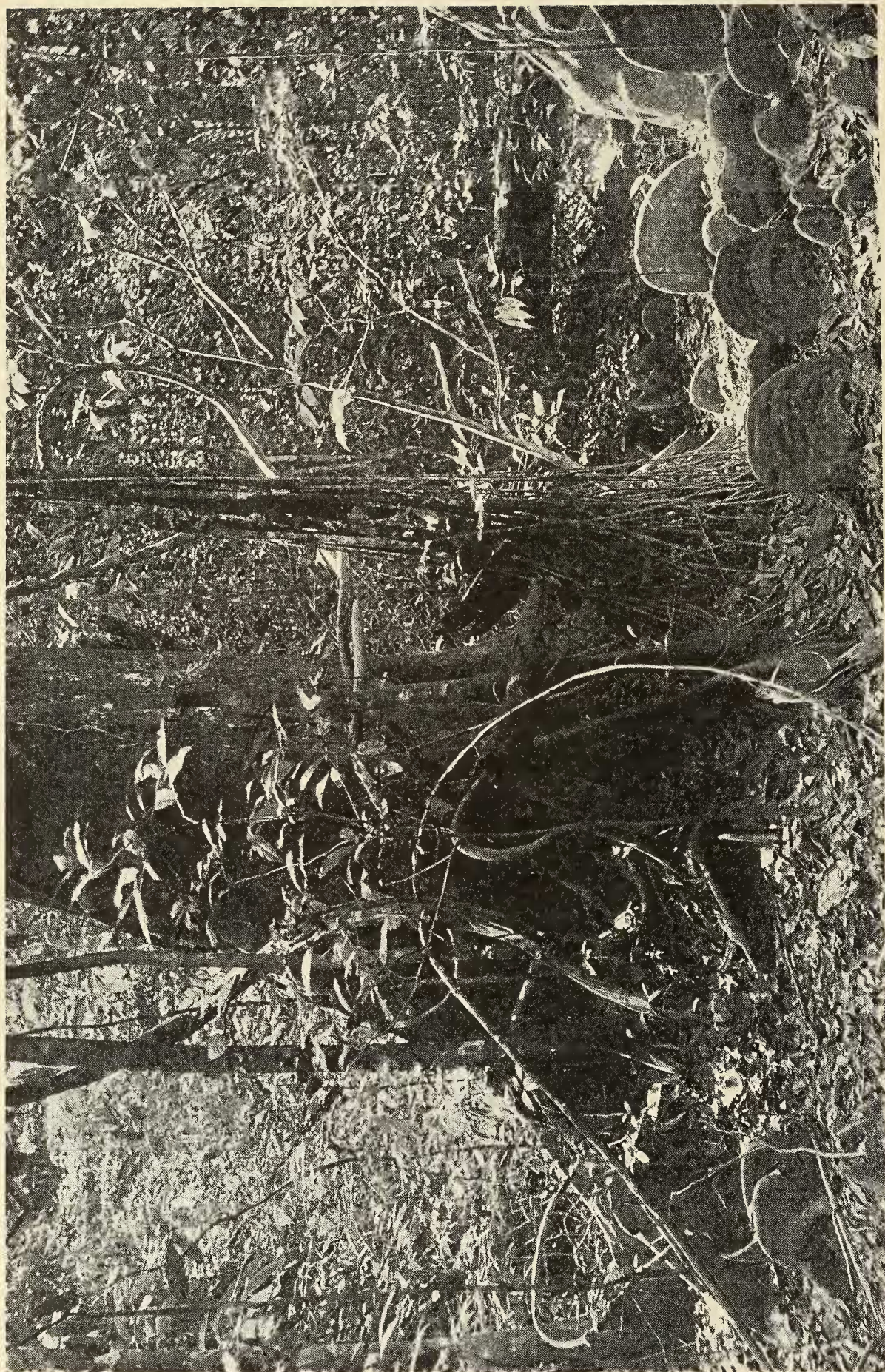


Fig. 5. A Mora swamp, where great exposed roots writhe and twist in fantastic shapes.
Photograph by Thomas Smolucha.

Tapirira guianensis Aubl.

Duka: Occasionally found in the jungle, eighteen inches through; the bark is reddish, not light, and the trunk marred with old branch stubs. Very rapid grower in new clearings. Has edible, purple, grape-like fruit.

Unidentified.

Arrancanduck: Moderately tall tree, large coarse leaves.

Psidium guava.

Cockreeou, Wild Guava: Medium tree, olive gray bark, smooth as if oiled. Many stems shoot up from old stumps; large broad leaves. Introduced from high lands.

Humirium floribundam Mart.

Tauroneero: Large tree, often with a few dead upper branches on which birds love to perch. Abundant. Fruit is edible, wood dark reddish, extremely hard.

Tenipa americana Linné.

Makreekoonee: Fairly tall jungle tree, variegated, slightly roughened bark, medium sized leaves. Bark makes a black dye.

Jungle Palms

Astrocaryum tucuma Mart.

Cuyuru Palm, Acqueero: Thorny-stemmed, a tall sentinel in front of laboratory: fruit eaten by Indian children and by animals.

Maximilliana regia Mart.

Kokorite Palm: Grows very tall; small, recently sprouted ones are common.

Cocos nucifera L.

Cocoanut Palm: A single one, full grown, in D 6.

Mauritia flexuosa L. f.

Eta Palm: Enormous stemmed and leaved, with equally large curtains of blossom and fruit. A very large one at edge of tide in G 3. The young, unopened leaves furnish the well-known tibireri twine, of which "grass" hammocks are made; the dry, pithy stems of the petioles make excellent razor strops.

Euterpe edulis Mart.

Manicole Palm: Characterized by huge palm-leaf fan fronds.



Fig. 6. The jungle laboratory at Kartabo, beneath giant bamboos planted 300 years ago by the Dutch.
Photograph by Paul G. Howes.

Clearing

Immediately about Kartabo laboratory are twenty-five clumps of bāmbōo, covering a compound of three acres. These are a very tall Javan species, imported and planted by the Dutch two hundred and fifty or three hundred years ago. They are ideal for bungalow trees, as they provide abundant shade, yet let the air pass freely; they are almost immune from insect attack, and their dense carpet of leaves forms a clean dry footing and prevents the growth of weeds. They respond to the least care, and when a clump is cleared out, the young shoots appear and grow with astonishing rapidity. A new sprout two feet high may in a very short time tower far above one's head. We made two estimates of growth, during the early part of the rainy season, and found that vigorous young shoots grew from eight to twelve inches a day. One of these increased in height from three and a half to sixteen feet in sixteen days. Parasites are unable to gain a foothold on the clean, hard, siliceous stems, and even the leaf-cutting ants have no use for the leaves.

West of the laboratory is a clearing of seven acres which four years ago was in coarse grass. Even after this time it could still be called a clearing, but another full year reduced it to a glade, with tall saplings sprouting in all directions, and the jungle creeping in from all sides. This change is a most interesting one, and the alteration from jungle affords opportunity for hosts of strange organisms, floral and faunal. Throughout the area covered by most of the research work at Kartabo Point, two thousand by four thousand feet, as well as further inland, numerous trails have been cut, which afford easy access to the lateral areas of jungle. To the south of the laboratory a field is cleared and under cassava, bordered by tall jungle trees, and this again exhibits entirely different associations rich in new conditions of floral relationship.

In the clearing, every patch of open ground is carpeted with a dense growth of the cheerful little pink Mazaruni primroses, *Sipanea pratensis* Aubl.,—by far the dominant color note of the open and with many tiny weevils and other insect hosts. With them are numerous other small flowering plants, such as *Spermacoce verticillata* Linné and *caerulescens* Aubl., and such curious little growths as the Christmas-tree plant, *Dupatya*. The waist-deep, meadow-like parts show dense growths of Vervain, *Stachytarpheta cayennensis* Vahl, and Velvet Leaf, *Sida cordifolia* Linné, together with clumps

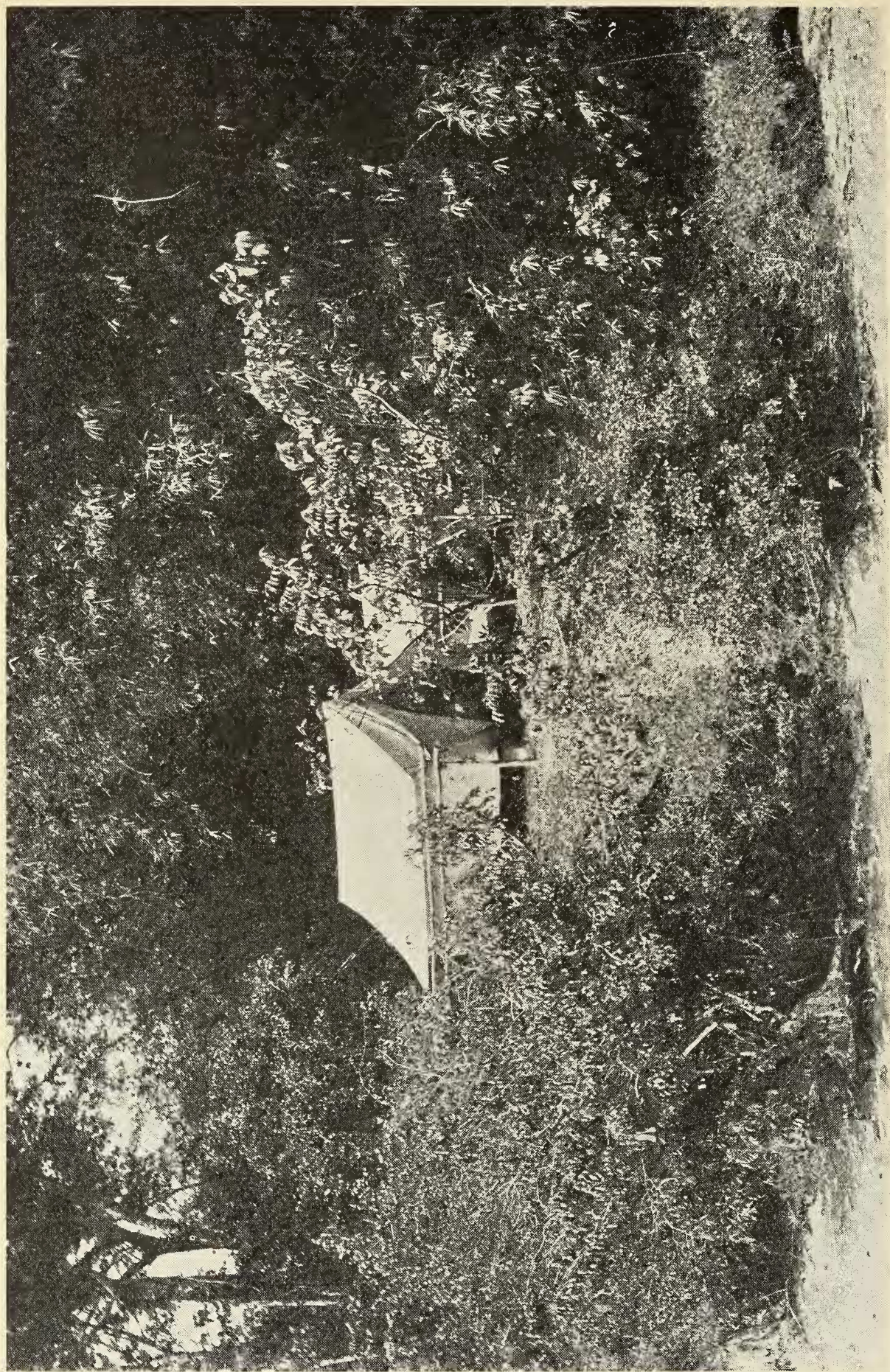


Fig. 7. The row of tents at the edge of the jungle that serve as sleeping quarters for the Staff.

Photograph by Paul G. Howes.

of plume-grass and scores of unnamed growths. Scattered here and there are taller patches of Orinoco boneset, *Mikania orinocensis* H.B.K., some of which burst suddenly into flower at the end of December, while others blossom from March to May. It harbors many interesting Hemiptera,—coccids and membracids. Sprouting plants of Cashew, *Anacardium occidentale*, are common. The fleshy, pear-shaped receptacle of the fruit is an edible astringent, greatly beloved of tanagers and other birds, and the kernel of the kidney-shaped fruit at the end of the receptacle, when roasted, is an article of commerce. The intermediate layer of fruit contains an acrid caustic oil.

In unexpected places great clumps of strange lilies, *Cruium*, spring up, their beautiful white petals filling the whole compound with their fragrance, and isolated plants of scarlet tiger lilies tear colorful gaps in the mass of clearing green. The pinwheel flower, *Tabernaemontana undulata* Vahl., shows one of the most amazing floral-fruit transformations, its gaping scarlet and black fruit developing from the tiniest whorls of petals. There is also the Tree of Life, *Bryophyllum pinnatum* (Lam.) Kury., as much at home as I have seen it in Ceylon and a score of other places. Sensitive plants, *Mimosa polydactyla* H. & B., wilt at a touch and scattered about are stray bushes of Indigo, *Indigofera* sp.,—heirlooms of thrifty Dutch settlers, which have handed down their seeds for perhaps three hundred years. Vines wind in and out, simulating the lianas of the nearby jungle, unnoticed until revealed by a sudden burst of blossoms, as the allamandas and convolvulus.

A still larger growth may be defined as saplings, of which the Duka, *Tapirira guianensis* Aubl., is the most rapid grower. At present there are scattered through the western part of the clearing, dozens of their light-colored, lichen-marbled trunks, with oval, pinnated leaves. With these, young jungle trees, such as Wareemeah, are sprouting from stumps of the old forest. There are also a few lime trees, *Citrus medica acida*, planted many years ago, and smothered in low growths, but still bearing abundantly. Guavas, *Psidium*, also grow here and there, and attract birds and wasps and even small mammals which feast on their fruit.

Here and in many other places, both clearing and jungle, *Melastomas* grow rank, some as trees, others as shrubs, bushes, or even crawling, vine-like, over open sandy places. One form, called Mesopra by the Bovianders, *Bellucia grossularioides* Triana, is common

about the bungalow, with great, coarse rough leaves, woody, scaly stems and rounded white blossoms, all a haven for a whole fauna of insect life, while the whitish berries are delicious eating.

The Clearing Trail, which is merely the beginning of the seventy-two mile Puruni Trail, where it leads westward through the clearing is perhaps the most interesting place near the laboratory. It lies along the seam, the very point of meeting of jungle and clearing, and a single yard to left or right often marks an entirely distinct flora and fauna.

The jungle edge hides its bareness with a dense growth of shrubs and half trees, often flowering profusely and attracting hosts of insects and birds. Among these is torchwood, or Haiawa, *Icica heptaphyllum* Aubl., with its dense foliage, whose wood, when pounded and teased out, is used by the Indians for candles, Blood-leaf, *Vismia ferruginea* H.B.K., and *guianensis* Pers., with great leathery leaves, beloved by a multitude of insects, Trysil Trees, with the finest of pinnated foliage, Arrancanduck, and Cassia, whose great golden panicles are Mecca to all lovers of nectar, whether scaly or feathered, with six legs or two. Here too we find tree Cashews, Clusia, Wild Cocoa and Messopra, with small flowers, and Maibike with its stems lined with lavender bloom. Here grow the exquisite Shooting Star blossoms, *Posequeria latifolia* R. & S., whose ultimate seeds look like rounded pebbles of translucent quartz.

Along shore, the edge of the jungle is varied by many smaller trees and vines, some of which are characterized by great solid masses of bloom at certain seasons.

Here grows the wild cocoa, *Pachira aquatica* Aubl., flowering twice a year, each blossom a foot across, a plume-like mass of lilac-colored stamens, followed later by the great leather colored pods, the resemblance of which to cocoa pods gives the common name. The close-packed seeds are delicious, either raw or roasted. Cassia is common here, and *Posequeria*, but vines have the best chance and a single plant may sometimes ramify for several hundred feet along the wall of jungle foliage, climbing to the very top. Especially noticeable are Allamandas, Bignonias, Petrea, and *Souroubea guianensis* Aubl., the last with its glossy leaves and panicles of stiff, scarlet flowers, whose fragrance is delicate and very penetrating. When a tree is entirely covered with this vine in full flower, it is a source of constant attraction to honey-creepers, hummingbirds and hosts of bees. Its near relative, *Marcgravia*, vies with it in abundance along

the shore and sometimes presents a solid front, quite obscuring the foliage of its supporting host behind. Its umbels of curious nectaries surmounted by the drooping circle of flowers are still a mystery as to their exact method of fertilization, whether by hawkmoth, hummingbird, or otherwise.

Another shore plant, which in certain positions becomes almost a vine, is the caterpillar flower, *Combretum laxum* Loebl., with its brilliant yellow and scarlet blossoms, which day by day unfold more of their furry lengths.

The Maibikè, as the Akawais call it, or Aliku, Benda, or Waikè, as the Bovianders name it, *Pithecolobium latifolium* Benth., forms bushes or moderate sized trees growing along shore, flowering in mid-July—a mass of rose colored bloom, solidly lining the branches. Bees, butterflies and many other insects come to it in swarms.

Spider lilies, *Hymenocallis*, hold up their drooping, streaming petals from among the sedges and reeds, while in swampy areas grow great clumps of ginger lilies, *Hedychium coronarium* König; in dry clearing edges appear, in the early rains, single plants of scarlet tiger lilies, *Hippeastrum*.

Although the jungle growth is so luxuriant, yet the soil is very thin, a mere skim of black mold from six inches to two feet lying on the sand or clay. An Indian's cassava field planted in fresh-cleared jungle soil will so deplete the ground that a second crop is never attempted, but the Indian allows the jungle to cover the clearing, while he cuts a new one.

In this immediate vicinity, on the opposite side of the river at Kalacoon, three exhaustive attempts have been made to raise crops on a large commercial scale, first sisal hemp, then rubber, and finally cassava. All have failed, the first because the humidity was too great to dry the fibre satisfactorily, the second because of lack of vertical root space and a devastating leaf disease, and the third because of general expense of labor and constant fertilization. Nature hereabouts gives freely of its riches of gold and diamonds, man may tap the wild rubber trees of the jungle or with effort carry off a few mighty boles to be sawn into lumber, but as yet she suffers no permanent replacement of her primeval jungle with plants of man's domesticating.

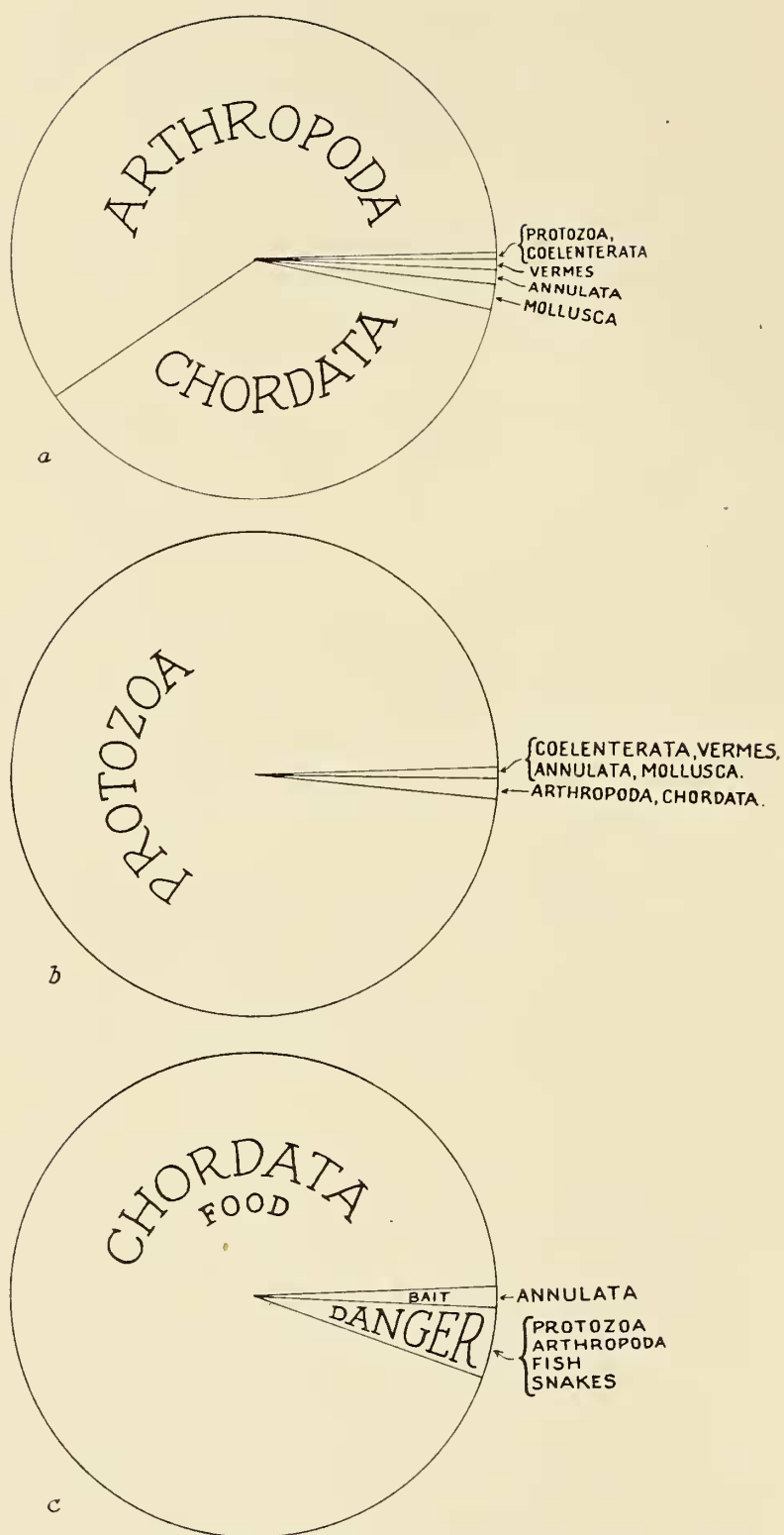


Fig. 8.—a, Apparent relative abundance of Kartabo Phyla. b, Actual relative abundance of Kartabo Phyla. c, Relation of Kartabo Phyla to human life.

VI—THE FAUNA OF KARTABO

Foreword

My treatment, in the present paper, of the fauna of the quarter of a square mile at Kartabo is of the most general character, intended as a preliminary skeleton framework for the more detailed ecological papers and monographs to follow. In addition it will serve to answer some of the numerous inquiries which I receive, relating to the presence or relative abundance of some family or other of organisms. In the case of the vertebrates I have included more detailed accounts of the interrelations in regard to food.

Taking into consideration the fact that most of the groups of organisms have not yet been worked up, nor the innumerable new species been named, I have thought it best, in treating of them, to make use of the simplest, most conservative of classifications.

As almost no two writers use our English terms of occurrence with the same meanings or relative values, I submit my own interpretation of the five relative terms:

Terms of Occurrence

Abundant—To be seen every day and on every walk.

Common—To be found whenever searched for.

Occasional—Uncommon.

Rare—Observed but seldom.

Unique—Recorded but once from the Research Area.

Probable—Present in numbers just outside the Research Area.

Phyla of the Animal Kingdom Found at Kartabo

I—Protozoa	VII—Molluscoida
II—Porifera	VIII—(Echinodermata)
III—Coelenterata	IX—Annulata
IV—Platyhelminthes	X—Mollusca
V—Nematelminthes	XI—Arthropoda
VI—Trochelminthes	XII—Chordata

Admitting these twelve Phyla in the Animal Kingdom, eleven are found within the zone of research at Kartabo. The missing one is Echinodermata, and while we are many miles from salt water, it was rather interesting and amusing to come across remains of sea urchins and starfish near the shore a few yards from

the laboratory. Unfortunately for our summary of living forms, however, these specimens of Echinoderms were in blocks of coral brought as ballast two or three centuries ago by Dutch sailing ships from some distant salt-water port. Here they were dumped overboard to make room for cargoes of sugar and letter-wood.

On this tiny portion of the earth's surface, this quarter of a mile of jungle and water, the animal life is quite undisturbed by man, and just as it has evolved through the ages. To unaided human vision, backed by enthusiastic interest, two phyla occupy about nineteen-twentieths of the entire animal life. With criteria of size and visibility we must represent the Kartabo fauna as in the adjoining Fig. 8, *a*. With actual number of individuals as guide the animal life would be rearranged as in *b*. Again, when the fauna is considered in its relation to the life of the native Indian, or in the case of our own physical life, it assumes a very different phase, illustrated in *c*.

One Hour of Jungle Life

The dearth of life and the silence in the tropical jungle is emphasized and reiterated in book after book of travel, and as long as the observer is actually travelling, he will indeed see little more than the few frightened creatures which rush from his path. When he is content quite to cease being a traveller, and become a stander, or sitter or squatter, the wealth of tropical life begins to be apparent. Even the patient digger or grubber will reap a rich harvest, as when once I searched and found a thousand living beings in a square yard of jungle floor.

Movement, not conspicuous clothing or human form, is the disturbing factor which drives a host of creatures into hiding just before the eyes can detect them, and makes a walk through a primeval forest often a disappointing experience. This can be mitigated by slow movements and intensive observation, and the following is the record of a walk within the research area, west from the Tropical Research Station at Kartabo, back along the Puruni Trail, from 7:30 to 8:30, on the morning of March 26, 1922. There was no wind; the first fifteen minutes were cloudy, while the sun shone brightly the remainder of the time.

I went slowly, making notes as I walked, for forty-five minutes. The last quarter of an hour I spent motionless in one spot near a deep

gully. Writing as rapidly as possible, with only an occasional glance at my note-book, I recorded every hint of living organism seen or heard, five hundred and thirty-six in all, and made a brief written or mental note about each observation. To this list I have added an occasional identification term to clarify my brief written word. It forms, I think, a satisfactory answer to statements of the paucity of jungle life.

Organisms Observed in Forty-five Minutes Along a Tropical Jungle Trail

Brain-fever Cotinga (*Attila*); heard the note of this beautiful bird as I left the Laboratory clearing at 7:30 A.M.

Kiskadee Tyrant Flycatcher (*Pitangus*) seen and heard.

Chestnut-breasted Seedeater (*Sporophila*) in full song.

Spine-tailed Swifts (*Chaetura*), three flying over.

Small Red Beetle.

Giant Black Orioles (*Ostinops*) three seen and heard, one giving courtship performance.

Cicada, heard south.

Dusky Nighthawk (*Caprimulgus*) flying up from trail; a true jungle bird, often perching on high limbs of trees.

Red-backed Caciques (*Cacicus*), two flying toward their nesting trees up the Mazaruni.

Green Trogon (*Trogon strigilatus*) heard giving its breeding song.

Black Cuckoo (*Crotophaga*) heard, whaleep! whaleep!

Small Green Caterpillar.

Green, Long-legged Fly (*Dolichopodidae*) walking swiftly about on leaf.

Small, Black Ichneumon-Fly searching for spiders.

Green Tree Snake (*Oxybelis*) moving slowly through branches.

Large, Brown Cricket (*Eneopterides*) chirping with its vibrating wings.

Green Membracids, eight of these attended by ants on a weed stem.

Small Brown Ants, three running on ground.

Green Dwarf Woodpecker (*Picumnus undulatus*) hammering at an insect's cocoon in a rolled-up leaf.

Small Brown Robber Fly (*Asilidae*) eating prey on leaf.

Blackish Birds, two, unidentified, flying through jungle.

Silver-beaked Tanagers (*Ramphocelus*) two in tree tops.

Yellow-lined Grasshopper, a clearing species, rather out of place in the forest.

Wax-covered Coccids, a group attended by ants.

Large Blue Hunting Wasp (*Pompilid*) half flying, half walking over leaves.

Antbirds (*Formicariidae*), three, unidentified, in dense foliage.

Small Metallic Fly (*Volucella*) on leaf.

Land Crab (*Cardisoma*) scuttling into underbrush.

Metallic Flies, three more.

Giant Green Grasshopper (*Acrididae*) crawling up tree trunk.

Jungle Pigeons (*Leptoptila rufaxilla*), two males calling loudly from neighboring trees.

Organisms observed—continued.

Red Ants, four on guard with jaws raised, on leaf.

Small Brown Cricket.

Rufous Hermit Hummingbird (*Phaethornis ruber*) flying across trail.

Small Brown Weevil.

White-spotted Membracids, three in a row along stem.

Caterpillar of black papilio butterfly (*Papilio*).

Cicada calling, different species from other heard seven minutes before.

Guiana Motmots (*Momotus momota*), three perching in berry tree, swinging their tails from side to side.

Small Brown Grasshoppers, two on leaves.

Large Green Katydid on under side of leaf.

Small White-Spotted Beetle (*Chrysomelidae*) on leaf.

Turquoise-Winged Weevil.

Green-and-Black Chalcid Wasp, very small, searching under leaves.

Black-faced Frogs (*Leptodactylus mystacinus*) two in a small pit.

Green Ground Lizard (*Ameiva*), large male in pit.

Cayenne Hermit Hummingbird (*Phaethornis superciliosus*) squeaking among some flowers in a tree-top.

Robber Flies (*Asilidae*) two large, hairy individuals, mating.

Oblique-Striped Jungle Lizard (*Anolis*) scurrying over leaves.

Medium Metallic Bee (*Euglossa*) hovering close to ground.

Carrion Flies, twenty-four, of five species, around dead frog.

Land Minnows (*Rivulus stagnatus*) two of these land-traveling fish in a pit dug for trapping frogs.

Wood Roach (*Blattidae*) small brown roach on dead leaf.

Sulphur-and-White-Breasted Toucan (*Ramphastos vitellinus*), calling to the north.

Small Brown Caterpillars grouped together on leaf.

Woodpecker, unidentified, hammering to the south.

Small Gnats, a large cloud hovering overhead.

Quadrille Bird (*Leucolepis musica*) gave its wonderful call close to the trail three times, wholly different each time. Did not see it.

Green Stick Grasshopper (*Tryxalid*) resting in center of leaf.

Giant Black Solitary Ant (*Dinoponera*) walking up tree.

Rufous Hermit Hummingbird flying about my face.

Yellow-winged Deer Fly (*Tabanidae*) alighting on my hand.

Common Ithomiid Butterfly (*Melinea* ?) fluttering slowly along.

Crackling Manakins (*Manacus manacus*), a pair flying across trail.

Small Army Ants, a file passing rapidly over leaves and ground.

Bird-winged Morpho Butterfly (*Morpho menelaus*) zig-zagging rapidly past me up the trail.

Robber Fly with a small wasp in its jaws.

Hump-backed Flies (*Hylomyzidae*) resting on leaves.

Brown Ant on leaf.

Green Spider under leaf.

Ichneumon-Fly with white antennae flying slowly.

Small White-spotted Caterpillar on leaf.

Giant Solitary Ants, three on stem.

Organisms observed—continued

Large Brown Spider in web.

Ichneumon-Fly with yellow, black-spotted wings.

Giant Lineated Woodpecker (*Coephleus lineatus*) flying over in the direction of the bird which had been hammering.

Red Howling Monkeys (*Alouatta*) heard to the southward.

Jungle Pigeons heard in a new direction.

Green Spider devouring green fly.

Small Brown Ants, six on one leaf.

Large Chestnut Bee (*Xylocopa*) half buried in a yellow allamanda blossom.

Minute Gnat flying close to my eye.

Spot-winged Antcreeper (*Sclateria leucostigma*) two in vine near trail.

Carrion Flies and Ants on bird dropping.

Small Green Caterpillar looping along edge of leaf.

Yellow-headed Vulture (*Cathartes urubitinga*) swooping low, close over the trees.

Brown Coccids, many on a branch, attended by ants.

Small Green Buprestid Beetle.

Red-throated Caracara (*Ibycter americanus*) calling with loud raucous screams upon discovering me.

Cinereous Antbird (*Thamnomanes glaucus*) calling just out of sight in the jungle, also annoyed by my presence.

Quadrille Bird, a second individual appearing for a moment.

Ithomiid Butterflies, two alighting on leaves.

Green Wood Roach (*Panchloridae*) on green leaf.

Brown Silk Cocoon with chrysalid moving about inside.

Spiders, two fighting on small web.

Large Antbird, unidentified, flying swiftly across trail.

Callistes, Chlorophanes and Bright Colored Tanagers, eight in tall trees.

Large Red Ant on ground.

Small Black and White Butterfly (*Erycinid*) under leaf.

Small Black Flies, three waving their wings and whirling about on leaf.

Long-horned Grasshopper mimicking daddy-long-legs (captured).

Black Chalcid Wasp attacking pink caterpillar.

Guiana Wood Nymph Hummingbird (*Thalurania*) following me for some distance.

Short-tailed Swift (*Chaetura*) flying over.

Minute Gnats, three on a small flower.

Azteca Ants around suspended nest.

Metallic Jumping Spider with fly on leaf.

Termites or White Ants making tunnel near their nest on tree.

Black-fronted Antbird (*Myrmoderas ferruginea*) giving its teacher-teacher-teacher call near the trail.

White-headed Tayra (*Tayra barbara*) one of these giant weasels rushing down out of a tree and off through the underbrush with a great riot of noise.

Minute, Red-Spotted Spider hanging from strand of silk.

Hump-backed Flies (*Hylomyzidae*), two on leaf mating.

Mottled Spider on huge web (*Argiope*), with two blossoms, but no living prey entangled.

Organisms observed—continued

- Green-winged Macaws (*Ara chloroptera*), calling to the north, and later appearing, flying high overhead.
- Brown Loop Worm with front part of body sticking out from stem like a dead twig.
- Grey Jumping Spiders (*Attidae*) motionless on plant.
- Red Ant on ground.
- Hump-backed Fly.
- Tiny White Moth flying close to ground.
- Large Grey Robber Fly resting on twig.
- Large Species Hump-backed Flies, three on one leaf.
- Turquoise-backed Weevil under leaf.
- Mealy Amazon Parrots (*Amazona farinosa*) two flying from tree with loud screams.
- Pygmy Antbird (*Myrmotherula pygmea*) heard.
- Woodpecker hammering loudly ahead.
- Small Reddish Moth on leaf.
- Small Hump-backed Fly on leaf.
- Olive-backed Ovenbird (*Automolus infuscatus*), two feeding on small tree.
- Woodpeckers, two small ones, too high for identification.
- White-breasted Antwren (*Rhamphocaenus albiventris*) one seen and others heard; this one hanging upside down picking at a leaf.
- Spot-Winged Antbird seen near trail.
- Antbirds, two, unidentified, with the Spot-wing.
- Small Parrots, probably *Urochroma*, flying overhead.
- Red Howling Monkeys, a second band heard far to the west.
- Green Mantis gesticulating on leaf.
- Brown Robber Fly with unidentified prey.
- Brown, Yellow-lined Grasshopper, a tree-top species, on leaf.
- Macaws heard (probably the same birds).
- Membracids shaped like small nuts, eight attended by four ants.
- Coccids attended by minute black ants.
- Membracid with pillar-shaped thorax (collected).
- Small Hump-backed Fly.
- High-arched Membracid on same plant, attended by ant.
- Purple-breasted Cotinga (*Cotinga cotinga*) heard in distance.
- Small Inch-Worm on my sleeve.
- Small Brown Wood-Roaches, two running along trail.
- Crowd of Termites rushing out of their nest accidentally broken open.
- Metallic Carrion Fly on leaf.
- Lace-winged Fly (*Chrysopidae*) resting under leaf.
- Metallic Coppery Scarab Beetle resting on leaf.
- Dancing-Wing Flies (*Trypetidae*), gyrating on a leaf.
- Dumb-Bell-Shaped, Long-Legged Flies flying and on leaf, one elaborately courting the other.
- Small Metallic Green Fly (*Volucella*) on flower.
- Maggots (*Diptera*) thirty or more around a bit of carrion.
- Small Black and White Butterflies (Pierids, although an exact copy of *Heliconids*—genus *Dismorphia*).

Organisms observed—continued

Small Brown Dragonfly on tip of leaf.
Small Birds, two in tree, not identified.
Yellow-bellied Calliste Tanagers (*Tangara mexicana*) three in tree.
Large Hump-backed Fly.
Yellow-winged Deer Fly buzzing about my face.
Green Spider on green leaf.
Small Metallic Fly.
Small Brown Grasshopper.
Hairy Black Robber Fly.
Termites, small colony of these with snapping jaws.
Muscid Fly on leaf.
Dark Saddle Membracids with four ant attendants.
Golden Metallic Bee.
Four Black Trigonid Bees.
Two Ithomiid Butterflies.
White Flower-like Spider.
Two Volucella Flies.
Slender Black Ant.
Dolichopodid Fly.
Sulphur- and-White-breasted Toucans, a pair calling.
Guiana Motmots calling in their muffled tones ahead.
Small Copper Beetle dropping to the earth at a touch.
Minute White Moth.
Brown, Long-legged Ctenid Spider.
White-antennaed Braconid Wasp.
Small Brown Ants, three carrying a bit of food.
White-crowned Manakin (*Pipra leucocilla*), a male flew past
Yellow and Black Cercopid Bug (*Tomaspis ruber*).
Minute Metallic Fly.
Brown and Red Caterpillar.
Red-rimmed Black Hemipteron on leaf.
Giant Blue, Tarantula-Killing Wasp.
Three White-crowned Manakins, two males and a female.
 Dusky Parrots (*Pionus fuscus*), three calling from tree overhead.
Woodpeckers hammering, one west, a second south.
White-throated Thrush (*Turdus phaeopygus*), parent and nestling hardly
able to fly, pursued them but could not capture the young one.
Large Rhinoceros Beetle flying past.
Macaws heard, perhaps the same pair seen earlier.
Black-throated Trogon (*Trogonurus curucui*) heard and seen.
Yellow-throated Caracara (*Ibycter ater*), flying out of low tree screaming loudly.
Yellow-headed Vultures, two soaring past.
Small Swift, unidentified.
Small Gold-fronted Hummingbird, unidentified.
Large Jungle Damsel-Fly (*Mecistogaster*) fluttering slowly over the trail.
Small Hump-backed Flies, two on leaves.
Metallic Jumping Spider with small insect.

Organisms observed—continued

Saddle Membracids, eight adults and young, attended by three ants.

Furry Black Caterpillar eating leaf.

Small Robber Flies, two mating.

Tiny Red Caterpillar under rolled leaf.

Walking Stick Insect (*Phasmid*) hanging by four legs from a leaf, the front pair stretched out along the antennae.

Agouti (*Dasyprocta aguti flavescens*) rushing away from a wild plum tree, grunting loudly.

Small White Pierid Butterfly on flower.

Red Howling Monkeys heard, probably the same as the last band.

Cloud of Gnats in mid air.

White-fronted Antbirds (*Pithys albifrons*) three chirping close to trail, all seen.

Antbird, another species seen only for a moment.

*Army Ants (*Eciton burchelli*), a small fan of these ants, accounting for the presence of the antbirds.

Three Wood-Roaches scurried out from among dead leaves.

Two Daddy-Long-Legs hiding among the same leaves.

Large Brown Millipede (*Polydesmid*) crawling on ground.

Small Flies, six hovering over a dead spider.

Two More Wood Roaches.

Harlequin Jungle Cricket (*Rhipipteryx*) flew ahead of me.

White-fronted Antbird, a fourth individual.

Wedge-billed Woodhewer (*Glyphorhynchus cuneatus*) creeping up trunk of tree.

Yellow Chalcid Wasp resting on leaf.

Antbirds, flock of about a dozen in tall tree, unidentified.

Ameiva Lizard, rushing into hole as I approached.

Long-legged Dolichopodid Fly on leaf.

Giant Metallic Blue Bee flying past.

Tryxalid Grasshopper motionless on leaf.

Azteca Ants in nest suspended over trail.

Reached Gully at 8:15 and Observed the Following Organisms within Fifteen Minutes:

Red-fronted Woodpecker (*Tripsurus rubrifrons*) seen and heard hammering almost overhead.

Olive-backed Ovenbird (*Automolus*) seen picking up food from bottom of gully.

Amazon Parrots calling, not seen.

Mouse-Colored Bushbird (*Hypolophus murinus*) calling.

Small Ichneumon-Fly alighting on my hand.

Two Muscid Flies hovering over flower.

Minute Grey Moth flying nearby.

Brown Cricket calling a few feet away.

Palm Tanagers (*Thraupis palmarum*) heard and seen in tree.

Guiana Squirrel (*Guerlinguetus aestuans*) scolding me a minute or more from the center of a bush across the gully.

Organisms observed—continued

Red Howling Monkeys making a great uproar to the north, probably a new band.
Two Small Flies in mid air.
Minute Gnat flying about my eyes.
Macaws again, probably the same pair.
Reddish Robber Fly resting on leaf.
Ring-tailed Monkeys (*Cebus apella apella*) swinging by within fifty feet, passing close to the ground.
Large Ant with the tip of the abdomen jet black.
Trypetid Dancing-wing Fly.
Long-tailed Hummingbird, probably *Phaethornis*, flying swiftly.
Minute Yellow Ants, twenty in small flower.
Deer Fly buzzing close to my face.
Small Yellow Caterpillar under nearest leaf.
Small Ithomiid Butterfly flying slowly past.
Variegated Tinamou (*Crypturus variegatus*) calling to the south.
Papilio Butterfly alighting nearby and walking over leaf.

8:30 A. M.

Summary of Organisms Observed

Within an hour's time I made two hundred and forty-six observations and recorded five hundred and thirty-six living creatures. This included all five phyla of vertebrates, of which one hundred and twenty-eight individuals were birds. The details of this summary are as follows:

	Observations	Individuals
Mammals.....	8	12
Birds.....	71	128
Reptiles.....	4	4
Amphibians.....	1	2
Fishes.....	1	2
Insects:		
Lepidoptera, Imagos.....	13	16
Lepidoptera, Caterpillars.....	11	11
Hymenoptera.....	39	95+
Diptera.....	47	139+
Orthoptera.....	20	25
Hemiptera.....	13	43
Coleoptera.....	9	9
Odonata.....	2	2
Isoptera.....	3	30+
Spiders.....	11	13
Phalangida.....	1	3
Millipedes.....	1	1
Crabs.....	1	1
	246	536

PHYLUM I—PROTOZOA

To write of the single-celled animals of a locality is like considering the snow crystals of Greenland or the sand grains of Kartabo beach. My Indians know nothing of their existence, yet they help to make his benab livable, they compel him to cook his game almost at once, and in the end they usually kill him.

Even we who in the past have studied them and watched their successive generations, who can give names to some, and predict their haunts and reactions, almost never think of them until an injury becomes infected, or until the clear water of an aquarium changes to opacity in a few days. Unarmed with a microscope we would admit Protozoa to but small part in the fauna.

In an aquarium on my table one day were several armored catfish, and a floating leaf of a tropical water weed. Within a week the water became green and opaque, but without slime or odor. I found that it was almost a pure culture of the green flagellate *Chlamydomonas*, with a scattering of *Vorticella*. I estimated the number of large drops in the six thousand cubic centimetres of the aquarium at one hundred and twenty thousand. A greatly underestimated count of these green-shelled flagellates gives one hundred thousand to a drop of water, spread over a cover-glass. Another calculation, and I look at the aquarium with awe, for at the lowest estimate it contains twelve billion *Chlamydomonas*—all active, kicking themselves about with their several flagella, busily dividing into more billions and incidentally furnishing the five large catfish with the where-withal, apparently both oxygen and nourishment, for three months of undisturbed existence in this aquarium.

Observations on Protozoa have all been incidental to other work, but some general facts have been recorded. Of the three habitats, river plankton, swamp-mud and water, and the water in bromeliads, the last has proved to be by far the richest in microscopical life of all kinds.

Four Classes of Protozoa are recognized:

Class I—Sarcodina

Class III—Sporozoa

Class II—Mastigophora

Class IV—Infusoria

All of these are represented in the Kartabo fauna.

Class I—SARCODINA

Amoebae of several species and *Arcella*, the latter occasionally

in great numbers, abound in mangrove bromeliads; *Diffugia* has been found both on debris in Mazaruni current-moved plankton, and in deep swamp pools; *Actinophrys*, or a closely related form, occurs in plankton.

Class II—MASTIGOPHORA

Euglena, *Ceratium* and *Volvox* in bromeliads; *Chlamydomonas* and many other forms of this Class both in bromeliad and swamp water. *Gonium* is one of the most interesting of this group, the few cells clinging together with just sufficient definition of arrangement and division of labor, to adumbrate Metazoa.

Class III—SPOROZOA

Plasmodium is occasionally brought in the blood from Georgetown and other parts of the coast, but there is no indigenous malaria at Kartabo, owing to the complete absence of mosquito carriers.

Class IV—INFUSORIA

Paramoecium is common in bromeliads; *Stentor* has been dredged in Mazaruni mud, and found growing on the eggs of the small, surface-swimming minnow *Tomeurus*; *Vorticella* occurs commonly in infusions, in mid-river plankton, on fresh-water sponges below low tide mark one hundred feet from shore, and has been observed in good-sized colonies near the gill openings of healthy tadpoles of *Lepidactylus rhodomystax*.

Almost as common as *Vorticella*, in plankton, are colonies of *Epistylis*, but decidedly rare are the beautiful little sessile, cupped *Cothurnia*. *Opalina*, of several species, are common parasites of Amphibia.

PHYLUM II—PORIFERA

This phylum plays one of the smallest parts in the fauna of Kartabo. It is of great interest, however, in being one of the marine invaders of this fresh-water region—pioneers from the great oceanic fauna of sponges.

Class I—DESMOSPONGIAE

Family SPONGILLIDAE

The presence of fresh-water sponges is evident from any slide of plankton or river-mud debris, spicules being almost always visible,

mingled with the desmids and diatoms. Living sponges are not uncommon on disintegrating rock a hundred yards off the Laboratory beach, about a foot below low tide level. The rocks show colonies two to four inches in diameter, masses of spicules rising in glassy clusters like some strange crystals above the surface of the stone, the lower, living portion being covered with a thin, green veil of tissue. The spicules are very uniform, simple, smooth, transparent, slightly curved, blunt, almost truncate, thick and uniform in thickness throughout their length: they average .4 mm. long by .05 mm. in diameter.

Star-shaped spicules with six rays, and simple spicules with lateral irregularities are also found now and then in plankton.

Quite another type of sponge coats the under side of stones in one or two streams in the research area and especially in swift-flowing side streams of the Cuyuni above the first rapids. It is like a brown moss in life, and the spicules are very slender, simple, smooth, curved and needle-pointed at both ends, reaching an extreme length of 1 mm.

PHYLUM III—COELENTERATA

This is probably the least important Phylum in the research area, and as with Porifera, is an example of marine invasion. Both among the plants of *Victoria regia* and in the water of jungle creeks, I am always on the lookout for the fresh-water free-swimming medusa *Lymnocodium*, but have never found it.

Class I—HYDROZOA

Several times I have detected hydras, both green and brown, in bromeliad water, and twice a long tentacled form appeared in plankton debris from mid-river.

PHYLUM IV—PLATYHELMINTHES

Flatworms are common organisms in the research area, and few fallen logs are without one or more of the larger forms while as internal parasites they are less numerous. All four Classes are represented.

Class I—TURBELLARIA

The Kartabo Turbellarians or Land Flatworms are truly tropical in size and colors. Their habitat is rotten logs and dead bark, or less frequently the under side of moist jungle leaves. Some attain

a length of three inches. They may be leaf brown, with delicate shadings of darker along the edge, or mottled like lichens, or marbled grey and white, or with pink and black like the brevicipitid frog *Atelopus*. There is occasionally remarkable mimicry or at least a pattern paralleling that of slugs living in the same environment.

Class II—TREMATODES

Doubtless abundant, but I have observed them chiefly as parasites in fish; forms closely resembling *Cotylaspis* occurring in the gills, together with others quite unlike any usual type of fluke.

Class III—CESTODES

Tape-worms do not seem to be very abundant. Although no special search has been made for them they have been observed in all groups of vertebrates.

Class IV—NEMERTEA

A few small Geonemertean-like worms have been examined, living in decayed wood near the shore.

PHYLUM V—NEMATELMINTHES

Two Classes of Round Worms are present in the fauna of the research area.

Class I—NEMATODA

Parasitic round worms exist in enormous numbers as internal parasites in all groups from Arthropods to Mammals. Sometimes, as in the snakes of the genus *Xenodon*, large balls of hundreds of full-grown Nematodes are found in the intestine. A small round worm appeared under the skin of the instep of one of our members and lived for a week, moving slowly about until killed.

Filaria occurs as a parasite in the blood of most of the Indians and Bovianders or half-breeds who come to the station. It does not develop as elephantiasis as often as on the coast.

Class II—GORDIACEA

Hair worms are occasionally seen when dissecting insects, and several times dark brown ones, eighteen inches or more in length, have been caught in the water of the jungle creeks.

Class III—ACANTHOCEPHALA

These rotifer-like worms are common in the stomach and intestines of various fishes. A straight, oval form in *Pimelodus*, and a curved species in six or seven wholly unrelated types of fishes are both members of the family Echinorhynchidae.

PHYLUM VI—TROCHELMINTHES

Class I—ROTIFERA

Rotifers are abundant in all suitable places, infusions, creeks and river water, in isolated jungle pools and especially in bromeliads. Some are most remarkable forms and would well repay intensive study.

PHYLUM VII—BRYOZOA

Small colonies of *Plumatella* have been found in widely separated pools in the jungle, but this is one of the most poorly represented of all eleven phyla.

PHYLUM IX—ANNULATA

The true worms are represented by two Classes, the two remaining ones being altogether marine.

Class I—CHAETOPODA

Order I—POLYCHAETA

One of the greatest surprises of the Kartabo fauna was to find examples of this marine Order, so far beyond the reach not only of salt but even brackish water. When digging worms for bait in sandy mud close to the shore in H₃, in an area which is covered with water at high tide, Nereis worms were uncovered. When a six-inch individual was cut in half accidentally, a new head was regenerated in a few weeks at the front end of the posterior half. In 1919 in this extremely limited locality the worms were found to be fairly common. Two years later not a single individual could be found. They represent a new species.

Order II—OLIGOCHAETA

The Oligochaete fauna is a rich one at Kartabo; many species are common in plankton, in quiet jungle pools and swamps, and especially in bromeliad water. Very remarkable oligochaetes are occasionally seen in the latter environment.

Lumbricidae or earth worms are abundant both as to species and individuals. I have seen giants three feet in length living in swamp soil, while in every fallen log and under dead bark often high up in trees are small, scarlet, intensely active angle worms.

Class II—HIRUDINEA

One of the greatest distinctions between the jungles of Kartabo and those of the Eastern tropics is the total absence of land leeches in the former place. They are never seen on leaves or twigs, and for that matter are rare in any environment. Small ones are occasionally found in the water of creeks, and minute individuals in the gills of tadpoles and fish.

A large, five-inch, blood-red leech was once taken in mud. It showed little sign of external segmentation and had an extremely flattened head. After an hour in clear water it was found broken up into many small pieces, and had extruded a large Nematode.

PHYLUM X—MOLLUSCA

Although the Mollusca of the Neotropical Region are, as a whole, exceedingly abundant, this is not the case at the Kartabo Research Station. Whether due to the lack of lime or other cause, snails and slugs are far from numerous, especially as regards species. The group has not yet been worked up, but there are probably not more than twenty species altogether.

All but one of these are Gasteropods, of which about one-fifth are Prosobranchs, and the remainder Pulmonates.

An unnamed species of *Helicina* is found on the leaves of low jungle growths. This small, hairy form is an air-breathing Prosobranch. A giant banded *Ampullarius* is locally common in shallow water and near the coast forms the chief food of the hawk, whose beak seems formed especially for extracting the inmate from its curved shell. Clusters of greenish eggs of this snail are often seen on the stems of the mucka-mucka.

The giant among mollusks is *Orthalicus sultana*, extremes being four or even five inches in length, and conspicuously clouded and banded. Once during a short dry season, a large snail of this species aestivated on a beam at one side of the laboratory entrance, and we used it as a living knocker, beating a rat-tat-tat with the shell day after day without disturbing the hibernating occupant.

A new subspecies of *Auris distaeta* lives on leaves, sometimes

high up in the jungle. The most brilliant snail of this region is an unnamed *Corona*, with markings of yellow, brick red, grey and white.

Several species of large slugs of the genus *Veronicella* occur, brown or black in color, and are eaten by *Bufo marinus* and *Leptog-nathus variegata*.

On a few half-exposed rocks in mid-river are found a few bivalves, small fresh-water unios, probably of the genus *Saxicava*, the only representatives of this great group.

Mollusca is decidedly not a conspicuous or important phylum in this area of British Guiana.

Phylum XI—ARTHROPODA

Class I—CRUSTACEA

Crustaceans are in constant evidence along the tidal area, but inland they are seen only occasionally, in the shape of land crabs, or smaller types hidden within decayed wood.

Subclass I—ENTOMOSTRACA

All the Orders of this group except the barnacles (*Cirripedia*) are represented at Kartabo.

Order I—PHYLLOPODA

Among many others, *Daphnia*- and *Bosmina*-like forms are abundant in river plankton. I have found eighty-two individuals of the former in the stomach of *Tomeurus*, a surface-feeding minnow, less than half an inch in length.

Order II—COPEPODA

Cyclops and related genera occur in jungle pools and also in bromeliads. In river plankton their perfect, cast skins are present in enormous numbers, and the living animals are sometimes so abundant as to appear like a fine milky precipitate.

Strange parasitic forms of *Argulus* occur in several species and in various places, such as the tails of tadpoles and in the mouths of Perai fish. An undescribed species of *Dolops* lives on big six-foot catfish.

Order III—OSTRACODA

Cypris and another closely related form occur in bromeliads.

Subclass II—MALACOSTRACA

DIVISION I—ARTHROSTRACA

Order I—AMPHIPODA

Gammarus-like forms have been observed on three occasions but none collected.

Order II—ISOPODA

Parasitic Isopods are abundant, Cymothoidae on the gills of *Pimelodus* and other small catfish, and Bopyridae within the gill-covers of shrimps. This latter, a species of *Probopyrus*, is present on either the right or left side in twenty percent of the adult shrimps.

Sowbugs and pillbugs are abundant in the research area, under bark and in the wood of decayed fallen logs. The species are numerous. Small, dark-mottled Oniscidae, allied to *Philoscia* and *Porcellio* live under bark. I have found as many as seven in the stomach of a *Dendrobates* frog. Larger, dark-banded forms, fifteen millimetres long, with scarlet head and antennae, prefer moist leaves on the jungle floor as well as rotten wood. They belong to the marine family Ligydidae.

Armadillidae-like forms, rolling into perfect balls at the slightest hint of danger, live under bark.

At least eight species of Isopods have been collected in the quarter of a square mile, of which four are undescribed.

DIVISION II—THORACOSTRACA

Order I—DECAPODA

Suborder A—MACRURA

While there are doubtless many species of shrimps, the most abundant of the river shallows is *Palaemon amazonicus* Heller. It occurs in great numbers and is caught and used as bait by the Indians. Small, split bamboo traps called *mahswas* are used expressly for this purpose. Smaller species are found far up in the jungle creeks. The river shrimps are omnivorous and scavengers, being attracted by various jungle seeds, dough, termite nests, or old fish and meat. A giant species, lobster-like in size, of the family Atyidae is much rarer. It is rich brown in color, striped with yellow and buff with delicate blue mouth parts.

Suborder B—BRACHYRUA

Several forms of crabs are not uncommon and one is abundant. The small mangrove crab lives in large numbers in the crevices of rocks, under stones and in the pockets of tree buttresses. Its favorite haunt is the mangrove roots up which it climbs for many feet.

One specimen weighed 2.1 grams, was 16 mm. between the eyes, and had been feeding on vegetable debris and small insects. There is great variation in color, the general tone being neutral, like the mossy or lichened or muddy mangrove roots, the chelae being dull yellow.

Large land crabs are found near the shore in the dry season and several miles inland during the rains. They are handsome crustaceans with the legs brilliant scarlet, the claws yellow, and the carapace purplish-black, bordered with pale yellow.

A female had eight young in her caudal sac on May 10. They were 10 mm. across the carapace. She was of large size with her chelae stretching laterally 200 mm. Her carapace was mahogany-colored, exactly like a mora seed.

Nine species of birds have been found feeding on crabs.

Class II—ARACHNOIDEA

Of the ten Orders of this Class, I have found seven at Kartabo. The Palpigradi have not yet been found although they are known to occur both in Paraguay and Texas; Solpugi have escaped notice although this is within their range, and I have detected no Linguatulid. These latter have been found in an autochthonous family of fish, so that all the groups are probably represented.

Order I—SCORPIONIDA

Scorpions are common under bark and in old rotten logs, but very rarely seen about the laboratory. Two families are most abundantly represented; Chactidae, to which the majority of the individuals belong, with thick, short chelae and two lateral eyes, and Buthidae, less common, with slender thin chelae and three lateral eyes. They breed during the rainy season and it is not uncommon to find a mother scorpion with ten to twenty pale colored young riding on her back.

I have been stung once and three of my staff have at various

times had the experience which is like that of the sting of a medium-sized wasp. Twice I have seen these creatures striving to defend themselves against the attacks of army ants (*Eciton*), by picking the ants off one by one, with their claws, but this sort of defense is useless against these terrible insects, and again and again the ants are seen carrying the segments and even the sting of small scorpions.

Order III—PEDIPALPI

Whip scorpions are rather uncommon; found in much the same places as scorpions, with a preference for over-shot banks and the hollows of trees. A pair which crawled out of a deep hollow when a purple-heart tree was cut down were very large, the whips of the male spreading twenty-three inches. These belonged to the family Tarantulidae.

Very small, tailed whip scorpions of the family Shizonotidae live in rotten wood. In six months of constant searching for termite nests in logs, one of my staff captured ten and saw about fifty.

Order V—PSEUDOSCORPIONIDA

Family CHELIFERIDAE

Members of the genus *Chelifer* are common in rotten logs, fifty or sixty having been seen in a day. *Chelanops* and closely related genera are rarer, and usually under loose bark. Single large specimens have been taken clinging to longicorn beetles and to common bats (*Molossus*), but usually these creatures are found on their volant hosts in pairs.

Obisium of the family Obisiidae has been found only in the stomach of a *Dendrobates* frog.

Order VI—PHALANGIDA

Harvestmen or daddy-long-legs are very abundant both as to species and individuals, more especially on the edge of glades and clearings and on the upper beaches. They spend the day under leaves and come out at dusk. They sometimes gather in large moss-like masses. Their principal diet inland is dead insects, droppings and half-rotten fruit, but the beach forms are aggressively carnivorous, and kill and devour ants, crickets and newly emerged dragonflies. Many superficially resemble our northern harvestmen, others are large and more brilliantly colored.

They seem unusually immune from molestation, as I have detected their remains in the stomachs of only three vertebrates, *Bufo marinus*, that most omnivorous of amphibians, and of two birds, one a cuckoo, *Crotophaga ani*, and the other an antbird, *Sclateria naevia*.

Order VII—ARANEAE

Spiders perhaps lead the Arthropoda in point of species, and are second only to the ants and termites in actual numbers. They are as inconspicuous as the ants are dominantly visible, but a few seconds with a sweep net, or an examination of under foliage, or rolled leaves, reveals the enormous numbers of these creatures.

Some fashion individual webs of great beauty, while others build communal webs extending over many square yards and forming excellent collecting places, where many interesting insects become entangled. Leaping spiders hunt down their prey, flower spiders bite out parts of blossoms and sit in the gap, simulating the lost petals, small tarantulas nest in curled up leaves or build subterranean trap-door tunnels in the laboratory compound, others of the largest size inhabit the roof of the Station bungalow, and vie with us in hunting insects attracted to the lights. The variety of habits, forms, patterns and colors of spiders is endless and the group would form a splendid subject for research.

They occupy a midway position in the life and death struggle of these tropics—feeding on living prey of many kinds, and being themselves the sole food of hundreds of species of organisms. With thousands of hymenoptera hunting every leaf and twig to store their cells and caves, and with flocks of hungry birds and scores of lizards searching for food every hour of daylight, it is a wonder that these soft-bodied creatures can keep from extermination.

Besides their many Arthropod enemies I have found spiders in the stomachs of two fish, three amphibians, four reptiles, one mammal and no fewer than fifty-three species of birds.

Order VIII—ACARINA

Mites are exceedingly abundant, being found on all sorts of hosts and in every conceivable environment. Unattached ticks are rare in the jungle and it is seldom that I see more than one a week. The scavenger mites, Gamasidae, are found on many hosts, weevils being the commonest. Large-sized ticks, Ixodidae, are found singly

on snakes, lizards, amphibians and mammals, and very rarely on birds.

Harvest mites, Trombidiidae, locally known as *bête rouge*, are troublesome at times and places, especially in grass, although I have never known them to be as bad as on Long Island and the Virginian coast. They persist throughout the year, but are more abundant, or at least more irritating, in the dry seasons. The human blood seems to develop an immunity to the irritation of these mites, and after a few weeks their presence is seldom noticed. Almost every individual mammal, bird and land reptile is infested with these pests, usually in the form of clusters on various parts of the head.

A very few birds and lizards feed on mites, and the very tiny, newly-emerged *Bufo marinus* often make them their chief food.

Order X—TARDIGRADA

Two water-bears have been observed in a slide of water from mangrove bromeliads.

Class III—TRACHEATA

DIVISION I—ONYCHOPHORA

Peripatus is not rare when searched for in rotten logs, both in deep jungle and in clearings. Three were found in a certain rotten log lying out in full sunlight in the laboratory clearing, and two more in the same place a year later.

I have collected five back of the laboratory in the open clearing among the stems and roots of short grass, where there were no logs or wood of any kind, and very little protection from the sun's direct rays. They live well under damp bark, and I have had as many as eight young born from a single female.

DIVISION II—MYRIAPODA

Millipedes and centipedes are common, some of the former abundant, climbing up the trunks of trees, under bits of loose bark and in rotten logs; centipedes in dryer places, rarely in tents and dwellings. The bite of one of the twelve-inch centipedes would doubtless be very unpleasant, but certainly not dangerous if treated.

Millipedes would seem but indifferent food, yet many organisms choose them. Among others, millipedes are eaten by black cuckoos, *Crotophaga*, by *Thamnophilus* and *Formicarius* among antbirds,

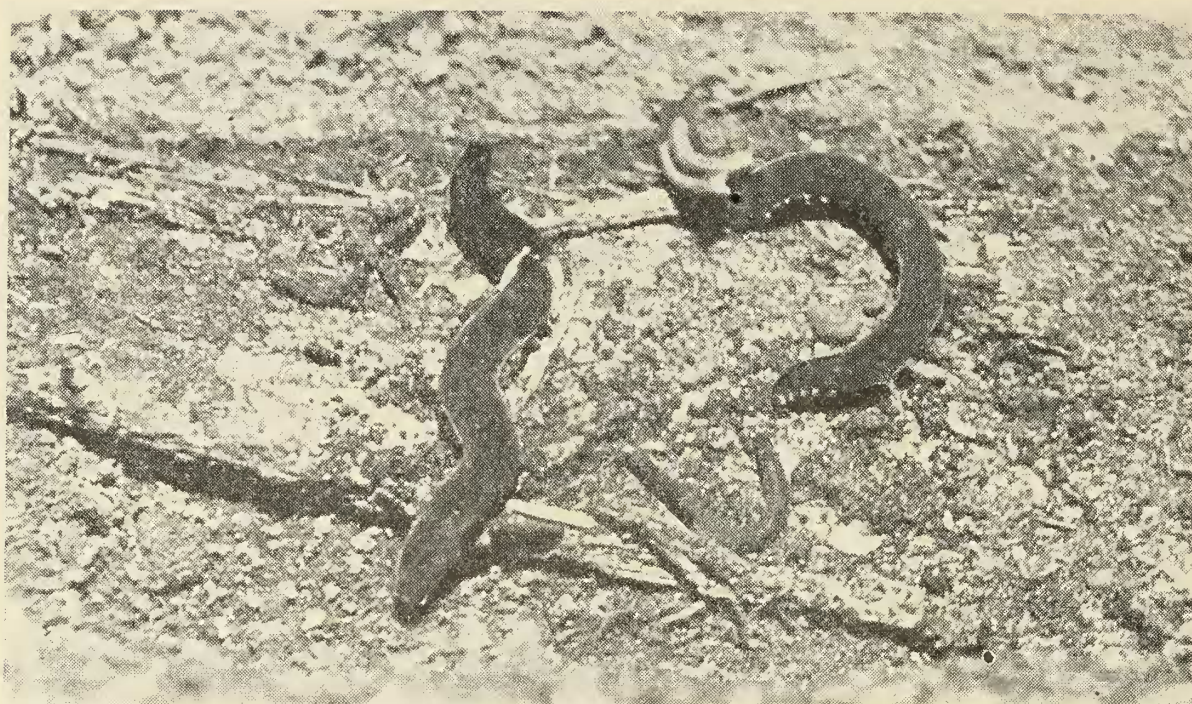


Fig. 9. *Peripatus*; one of the most primitive of Arthropods.
It is viviparous, and three newly born young are seen in this picture.
Photograph by John Tee-Van.

Xiphorhynchus and *Dendrocolaptes* among woodhewers, besides *Bufo marinus*, *Dendrobates*, *Ameiva* and *Plica*. Centipedes fall victims to the same species of birds with the addition of the hawk, *Leucopternis*, the antbird *Hylopezus*, and a jay *Cyanocorax*, in addition to *Bufo typhonius*, anolis lizards and the mammal coatimundi, *Nasua*.

Small, many-segmented, dark-colored millipedes of the family Julidae with eyes in clusters are fairly common and are eaten by *Ameiva* lizards, but by far the most abundant millipedes are the big brown Polydesmids, on trees, in fallen logs and under bark. There are nineteen body segments, they are two to three inches long, and roll up at a touch. When annoyed they exude an ill-smelling brown liquid, and are altogether forbidding as food, yet the insatiable *Bufo marinus* seem to enjoy them.

Giant centipedes with twenty-one segments, *Scolopendra*, are found occasionally, the largest so far being thirteen inches long. Two nine-inch ones were taken in a tent and a smaller individual was seen on a lofty dead branch feeding on a buprestid beetle. In the low jungle these are replaced by small ones, of twenty-three segments, with long, whip-like hind legs; all, however, are decidedly uncommon. Notophilidae and Geophilidae are represented by small-sized centipedes in rotten logs and on jungle debris.

DIVISION III—INSECTA

It would be indeed a rash thing to attempt an adequate survey of the insect life of even this quarter square mile of tropical jungle. Our present knowledge of it is most fragmentary, but sufficient to indicate the general relative abundance of the various groups and to reveal the dimensions of this extraordinary field of research. Together with birds, the insects assuredly hold the position of dominant organisms of the present day at Kartabo.

EVERY ORDER OF INSECT IS REPRESENTED AT KARTABO

I—Thysanura	XIII—Parasitica
II—Orthoptera	XIV—Thysanoptera
III—Isoptera	XV—Neuroptera
IV—Euplexoptera	XVI—Mecoptera
V—Mallophaga	XVII—Trichoptera
VI—Corrodentia	XVIII—Lepidoptera
VII—Zoraptera	XIX—Coleoptera
VIII—Plecoptera	XX—Strepsiptera
IX—Ephemera	XXI—Diptera
X—Odonata	XXII—Siphonoptera
XI—Hemiptera	XXIII—Hymenoptera
XII—Homoptera	

Order I—THYSANURA

Suborder I—CINURA

These lowly insects are abundant, no rotten log or mass of dead leaves being free from so-called fish-moths. They are free living, many as long as eight or ten millimetres, usually pale yellow, and very active, scurrying about the porous wood, and so delicate that they are very difficult to capture without damaging antennae or cerci. Smaller, translucent green forms are found in myriads on the under surfaces of leaves and still others such as *Atelura* are termitophilus or found associated with ants. *Nicoletia* is also not uncommon.

Suborder II—COLLEMBOLA

Collembola are less numerous than Thysanura, but occur in much the same places. One of the most remarkable forms is a little creature of a wrinkled, velvety indigo color, with a reduced springing apparatus. Others, Poduridae, are abundant not only on

rotten wood but in the debris of the upper beach, where they gather at night in hundreds about half-rotten fruit or other organic flotsam and jetsam. *Borecus pinnatus* is very abundant in termite nests. One group of tiny wasps, *Microstigmus*, stock their hanging, bell-like nests with nothing but spring-tails.

Order II—ORTHOPTERA

Family BLATTIDAE

The common roaches of the bungalow are wide-spread species of *Periplaneta* and *Pycnoscelus* which, until we encouraged tarantulas and geckos, gnawed our clothes and books, and destroyed all insect specimens which were not kept on swinging shelves.

In the jungle, roaches outnumber all the other Orthoptera, occurring chiefly among fallen leaves and debris, but as they enter into the food of many tree-climbing and leaf-searching birds, they must be almost universal in their love of hiding places. At least a score of species may be called abundant or common.

Family MANTIDAE

Egg-cases, newly hatched broods and full-grown mantids occur everywhere that green leaves are found, but they are common rather than abundant. The majority of the species are brown, but others are green, with sometimes discolored or transparent spots. Some are ornamented with brilliantly colored ocelli and other patterns, while the flower mantids vie with any orchid in coloration.

These insects are readily kept alive for months, exhibiting interesting feeding habits, now and then depositing a mass of eggs, and becoming quite tame. Two lizards and at least five species of birds include mantids in their diet.

Many jungle forms fly to our lamps at night. Over twenty-one well-known species have been taken, besides many still undescribed.

Family PHASMIDAE

It is in this family that tropical Orthoptera reach their most bizarre development. On the leaves and branches of low bushes in clearings, in mid-jungle and on the foliage of trees which are chopped down, are found walking sticks, minute, medium, and occasional giants eleven inches long. Some are smooth and enamelled, others roughened, or with foliaceous excrescences: wingless, or with tiny parodies of wings, or fully functional expanded membranes: and

finally insects which appear to be nothing but animated green, veined leaves.

When the wings are too small to fly with, they often function as flash organs. A stick insect will suddenly snap open a sheet of brilliant yellow and scarlet, the colors shooting out from an apparently dead twig, in the most startling manner.

These insects have learned to support themselves on three or four legs, and to dangle the remainder in midair; they also sway when disturbed, as if a breeze were moving them. They do not do well in captivity.

Family ACRIDIIDAE

The short-horned grasshoppers are first among the families of Orthoptera in numbers, and they swarm in every open glade, and especially in clearings. They fly up at every step and their flight is directed invariably toward or into the shelter of the denser jungle. About thirty species are common.

Tribe TETTIGIDES

Ten species of the little tettix hoppers, with solid dorsal armor, are common and found almost exclusively on the trunks of dead or fallen trees. They are remarkably like the hue of their particular trunk, and within fifteen feet I have found a brood of very dark tettix on a dark-barked trunk, and pale, mottled ones on a tree covered with parti-colored lichens.

Tribe TRYXALIDES

These stick grasshoppers are such good imitations of dead twigs that they choose to rest quietly on branches quite exposed throughout the day, waiting for night to come. Or if they become too hungry, they begin eating the edge of leaves with very slow and deliberate movements, scarcely to be distinguished from the motion of the leaf on which they rest. Head, body, antennae, legs, all are twiggy, and so completely do they trust to their invisibility that they may be picked up without careful approach. They are common but never abundant.

Tribe ACRIDIIDES

As in northern lands, these "meadow" grasshoppers are the dominant form of Orthoptera. As members of the same tribe we must count the tropical giants which reach a length of six inches,

whose wings when spread in flight are as large as those of a good-sized bird, and more brilliant than many. These insects prefer the edge of the jungle and clearings.

Another large form is clad in a livery of scarlet and black, and the wingless mynphs appear in a solid phalanx of one or two hundred, travelling steadily through the jungle or across a grassy clearing, walking slowly, and hopping only when frightened. They show no fear of birds or lizards, and although anis eat them, and an occasional one is found in an *Ameiva*'s stomach, they flaunt their brilliancy because of a general immunity. All my pet monkeys and birds refused them, even when sandwiched in between edible species which were seized and eaten ravenously.

Jungle grasshoppers are found singly, many with leaf markings, or a broad ruptive streak down the back, and often with hidden flash colors, such as scarlet inner thighs, or abdominal tints, visible only in flight.

Family TETTIGONIIDAE

Long-horned grasshoppers are almost all extremely protectively colored, and as they are nocturnal, discovery of them in the daytime is usually accidental. They frequently come to light. Under the leaves of bushes and trees the narrow and broad-winged katydids rest, climbing to the upper surface and becoming active just before dusk. The extreme to which hypertely is carried is astounding—green leaves gnawed and jagged around the edges, leaves decayed to red and yellow hues; leaves with a center of skeletonized network; most of these belong to the tribe Meconemides.

A second tribe Mecopodies, is represented by fewer numbers, but very striking species; great three-inch, winged forms, lichened in hue and texture, living on tree-trunks and old logs, and brown-leaved long-horns clinging to bare branches like the last dangling sear leaf.

Family GRYLLIDAE

This family ranks fourth in numbers and conspicuousness, but in audibility it stands first. Of the seven known tribes, all occur at Kartabo, five are common, two rare, although Myrmecophilides would undoubtedly be recorded more frequently if the nests of ants were searched systematically. I once found representatives of all seven tribes of Gryllidae in a single day. Crickets are found from the very margin of the river to the highest dryest jungle, but seldom

at a greater elevation than a few feet from the ground, while the majority are wholly terrestrial. The season makes some difference in their numbers, and more in regard to their singing—the season of mating being dominantly the early part of the two rainy seasons, about May and November. Three tribes come occasionally to light, but singly and only on rainy evenings.

Tribe TRIDACTYLIDES

Common and sometimes abundant along jungle trails is *Rhipipteryx*, a black and white member of this interesting and little-known tribe. They are not wary, but are very conspicuous, and when frightened escape by tremendous leaps, followed by a long scaling flight. They feed upon the juices of decayed wood, and perhaps of leaves as well, and are sometimes found in scores in and on a single dead log.

The hind legs have been so modified for leaping that they have quite lost their walking function, and these insects are wholly quadrupedal. I have twice detected robber flies, Asilids, in the act of devouring these Orthoptera.

A very minute, closely related, similarly modified insect is found on the sand of the beach in company with springtails, and newly-hatched mole-crickets.

Tribe GRYLLOTALPIDES

There are two general types of mole-crickets at Kartabo. A large, very pale species confined to the sandy beaches and a smaller black kind, which occasionally comes about the waste baskets. Both are attracted by light, the beach one more frequently.

The littoral species is always to be found after dark, running over the sand. At the very edge of the water at low tides many young ones often run about, and individuals of all sizes are occasionally seen swimming. They are very fierce and cannibalistic, and if several are confined together, one only will be found in the morning. In the daytime holes and long tunnels are visible. There is no doubt that these insects spend the time of high tide hidden in the sand, beneath the water. When placed in a thick layer of sand and covered with water, they are well and lively after eight hours' immersion.

Tribe GRYLLIDES

The true crickets are represented by a number of species, most of which have habits similar to those in the north. They are usually

terrestrial, and in the jungle very tiny black ones are found under the fallen leaves. Others live beneath bark. Some of large size and others with square, yellow-rimmed wing covers, are very fleet of foot, and flat enough to creep into the smallest crevice. Tiny pale brown crickets come to the lamps in the evening, and numerous small, nocturnal voices are doubtless traceable to insects of this group.

Tribe OECANTHIDES

Although arboreal crickets are found in the highest jungle trees, true crickets are rare and I have seen but two individuals of a small green form, closely resembling a similarly colored species of Trigonid.

Tribe TRIGONIDIIDES

The beautiful little Harlequin crickets prefer the more open trails and clearings to the darker jungle, and are found on bushes and low-growing vines, seldom quiet but running rapidly about, with palpi rapidly vibrating.

There are a number of species, almost all of bright coloring, although one is dull brown and another pale green. The nymphs of one Harlequin afford the most perfect mimicry of ants I have ever seen. The resemblance is exact to every superficial detail, the tell-tale thick hind femora being of a pale translucent green, which is invisible against almost anything, and yet ready at an instant's warning to carry the wingless insect at least a hundred times its own length. They associate with certain ants with impunity, and I have seen them crawling over membracids in company with a crowd of ants. In the ant¹ mimics, the antennae are short, but in others which are very like small wasps, the antennae, while long, are amputated by a terminal white portion, reducing the optical length to the correct hymenopteron extent.

Tribe ENEOPTERIDES

A large jungle leaf-cricket is the most abundant of its family at Kartabo. It lives on leaves in the jungle, or among bushes of the clearings. It is leaf-brown above and black on the sides, the color division cutting abruptly through face, antennae, eyes, body and wings. It is a persistent singer, and easily located from 5:00 P.M. until dark, on a leaf of some low bush, with wings elevated at right angles to the body, and hind legs drawn up to the same angle.

The song is a true trill, less than half a note apart, the wings vibrating slightly, but not enough to blur them. The tone comes in successive waves and is about an octave below middle C, although the quality makes it difficult to key it.

Order III—ISOPTERA

From the point of view of an intruding human being, termites or "white ants" rank second in a list of dominant organisms at Kartabo. These insects are without doubt the chief agency in the disintegration of dead wood in the tropics, with the consequent rapid return of the decaying plant material to the soil, thus making possible its utilization for the growth of other plants that spring up in place of the trees that have fallen. The burrows of termites also open the way for the invasion of molds, fungi, bacteria and water, which further the process of decay. It is Prof. Emerson's conviction that much of the luxuriant and rapid growth of plants in the tropical forest is owing directly to the activities of these insects. The habit of using sand and dirt in the construction of nests together with the burrows that many species of termites make in the soil, results in the mixing and aeration of the soil.

In addition to these two influences which termites exert with the consequent enormous effect on the plant life of the region, these insects are so abundant in numbers that they form the chief food supply for a number of animals, particularly three species of ant-eaters, *Myrmecophaga*, *Tamandua* and *Cyclopes*, two species of burrowing snakes of the genus *Leptotyphlops*, and several species of woodhewers, woodpeckers and antbirds, such as *Glyphorhynchus*, *Chloronerypes* and *Formicarius*. Certain social wasps of the genus *Polybia* collect the winged forms as well as soldiers and workers, and several Ponerine ants (especially *Neoponera commutata* Roger) raid the open termite trails and enter their nests. During swarms almost every insectivorous creature from centipedes and spiders to hawks and bats feed largely upon these insects, and such unsuspected animals as terns and monkeys.

The nests of the termites, both terrestrial and arboreal, on account of their constant temperature, permanency, food supply of termites or debris, and because of the social instincts of the termites, offer a haven to numbers of specially adapted animals, mostly insects, which are fed and often even reared by the termites themselves. Over fifty species of arthropods have been found in termite

nesting near Kartabo, forming with the termites, remarkable biocoenoses, with fascinating and remarkable interrelationships between the animals composing them. Birds such as trogons and parakeets, and the large tegu lizards make their nesting burrows in the very heart of termite nests.

The intensive study of Kartabo termites from the quarter square mile of jungle, carried on by Prof. Emerson, demonstrates the great value of such restricted research. Until his studies began, there were sixteen species of termites known from the whole of British Guiana. He has now recorded from the tiny restricted fraction of the Colony under investigation, eighty-five species, which means that the completed census will most certainly tally over one hundred forms.

Order IV—EUPLEXOPTERA

Earwigs are much rarer than in the jungles of the Eastern tropics, where in Borneo and the Malay States I have found them in great abundance. At Kartabo they occur in varied environments, under stones near the water, under bark of dead trees and among leaves. An interesting blind form was dug up four feet beneath the surface of undisturbed soil.

Order V—MALLOPHAGA

Mallophaga or bird lice are found epizootic upon almost all the birds of this region, and a considerable number of mammals. Although I have collected them from many hundreds of freshly-killed vertebrates I have never found them occurring to excess.

Order VI—CORRODENTIA

These curious little insects have been observed several times in the jungle, twice under bark on hard, undecayed dead wood. In the laboratory Psocids or book lice are found in numbers running about the inner bindings of any book which is not in frequent use.

Order VII—ZORAPTERA

This exceedingly rare order of insects is represented thus far by a single wingless specimen captured in a termite nest.

Order VIII—PLECOPTERA

The little known stone flies are rare, and only a very few larvae and adults have been observed, the former in the sand of Cuyuni creeks.

Order IX—EPHEMERIDA

Mayflies are common and at certain seasons abundant, immense swarms emerging at one time, and dancing in mid-air. The one most frequently seen is a large form with a line of silvery white down the back of the abdomen. I have watched a vast swarm of these insects twenty feet up, dancing for hours. Facing upwind, they hold the wings steady, slowly sinking for a few seconds, when with a single downward sweep of the wings, they regain their former altitude, and again float like tiny airplanes for a time. Occasionally the surface of the rivers is covered with their wings and bodies.

Among many others, a species of *Campsurus* with its degenerate meso- and meta-thoracic legs is common about the laboratory lights in the rainy seasons.

Order X—ODONATA

A great many species of dragon- and damsel-flies have been taken in the quarter mile research area, but no attempt has as yet been made to identify them beyond families. Of the first mentioned group, all four families are present.

To the Gomphidae belong good-sized insects which keep to the vicinity of water. Although not as swift fliers as some others, they are not often seen or captured, for they usually fly among thick undergrowth.

The largest dragon-flies belong to the Aeshnidae. They are haunters of the jungle and come to any pit or tub of water however small. When I sink a tub for aquatic Coleoptera a single large *Epiaeschna* or *Nasiaeschna* appears at once and takes possession. It drives away any related intruders, and flies back and forth over the diminutive pond, occasionally laying an egg in a crevice of the soil near by. When at rest it hangs suspended from a leaf, with the wings, which spread four or five inches, opened and flat. They are far from wary insects and will alight on one's hat or clothing. Members of this family are often seen hawking about in the air in close association with martins and swifts, feeding on swarming termites or ants, and they join the bats in crepuscular hunting as well.

Smaller dragonflies belong to the Cordulidae, and have the wings usually quite clear, and the abdomen often of a deep purple or red color.

Numerous species, some very common, are included in Libel-

lulidae, often with banded or spotted wings or dashes of color. They are the typical dragonflies of the jungle trails and of dry clearings far away from water.

Two families of the damsel-flies *Zygoptera*, vary in size from the most delicate, azure-bodied beings, fluttering tremulously on the tiniest of gauzy wings over creeks, swamps and the shores of the river, to the marvellous, giant *Mecistogaster* of the high jungle. These have wings which expand five and six inches and slender abdomens which trail out behind to an equal length. Their wings may be clear, or tipped with spots of yellow or white, and in shadowed aisles of the jungle these terminal spots, weaving about in confused motion, are often the only part of the insect visible to the eye of the onlooker. They breed in the water of the bromeliad leaves, high up on the trunks and branches of trees.

The smaller damsel-flies have brilliantly colored bodies and sometimes spots of scarlet on the wings. *Agrionidae* is the more abundantly represented family.

Nymphs of *Odonata* are abundant in all conceivable aquatic places, in the waters of creeks, both slow and rapid flowing, along shore and even in the deep water of the river, in isolated pits and the water of air-plants.

Order XI—HEMIPTERA

CRYPTOCERATA

The distribution of these is of course restricted to water, which, apart from the rivers, consists of temporary rain pools, mica pits, small creeks, and, in the vicinity of the laboratory, flooded pit traps. Certain *Hebridae* and *Notonectidae* frequent these places. The bromelias found on the mangroves harbour at least two species of *Hebridae*.

Group GYMNOCERATA

Judged from this standpoint the immediate neighborhood of Kartabo seems to support two distinct groups of bugs. The first, and larger, both in number of species and individuals, belongs to the clearings, and as might be expected, this hemipterous fauna does not appear to differ very greatly from that of the cleared plantation lands near the coast. Indeed, it is probably immigrant, and likely to extend in range as the cleared land increases in extent. The second, and apparently smaller, is probably the older fauna, native

to the primeval jungle, in which the clearings are made. It should be understood that the terms aboriginal and immigrant are used merely for convenience in this connection. The neighborhood of Kartabo has been occupied by Dutch and British settlers for the last three hundred years at least, and the addition of forms from more open country to the original forest fauna must have taken place throughout this time. Except perhaps as regards the carnivorous bugs, this jungle fauna is more restricted both in species and individuals than that of the clearings. In both cases, the relative abundance of different species in proportion to the number of individuals obtained is very marked. The occurrence of the different species is probably influenced considerably by rainfall and other climatic factors, as Hemiptera of all families are relatively more abundant in September than during the rains of June and July. Three large families of Heteroptera predominate in the area, Reduviidae, Coreidae, and Pentatomidae, in numbers both of species and of individuals. The first family is abundant in jungle and clearings. These three families include species of every size, and in the Reduvids of considerable diversity of form.

The Pyrrhocoridae and Anthocoridae include none but small forms, mostly confined to the clearings, and the same may be said of the Phymatidae.

Family PENTATOMIDAE

This is a large and dominant group. Some of its numbers are conspicuous in size and coloration, others are small, sober-hued forms. On the whole, the Pentatomids frequent clearings and sunny trails, although certain forms of considerable interest are confined to the deep jungle.

Family COREIDAE

Perhaps the most remarkable group of Heteroptera in size, number of species and diversity of form are the Coreidae. Coreid bugs are found in the clearings and in deep bush. Some exhibit curious and almost grotesque developments of the antennae and limbs; others are brilliantly colored, perhaps to repel enemy attacks, or else are inconspicuous to avoid being observed. The nymphal stages are frequently very different from those of the adult; and some species appear to live on decaying organic matter rather than on plant juices.

Family LYGIDAE

In comparison with the above the Lygidae are not only less abundant in species, but the individuals are less conspicuous in size and coloring.

Families ANTHOCORIDAE, CAPRIDAE, PYRRHOCORIDAE

These are represented at Kartabo by a number of small forms, generally obtained in the clearings by sweeping, and readily overlooked.

Family PHYMATIDAE

Represented by a few species frequenting open places. The same forms are much more abundant in the grasslands near the coast, and may even have appeared up the river comparatively recently in the wake of negro settlers and consequent clearing of jungle.

Family ARADIDAE

A few interesting bark-dwelling forms, protectively colored, are found on tree trunks in the jungle.

Family REDUVIDAE

Ranks with the Coreidae as one of the dominant families. There is great diversity of form, size and habitat. Certain species show remarkable resemblance to insects of other groups inhabiting the same area. Thus one "mimics" a sawfly, another an ichneumonid, two others resemble two different pompilid wasps, another apes an inconspicuous grasshopper, and so forth.

Order XII—HOMOPTERA

Family FULGORIDAE

The most striking of these insects are the huge lantern- or peanut-headed insects which are seen very rarely on tree-trunks. Smaller fulgorids of the most bizarre shapes and colors are more common. A very typical jungle form is a large insect with black wings covered with turquoise dots, and a remarkable tuft of long, curving, waxen filaments at the end of the abdomen. They are sometimes common, clinging to the trunks of trees, and present a very curious sight when flying.

Family CICADELLIDAE

These are perhaps the most abundant of the volant Homoptera

in the Kartabo fauna. They are mostly small, with very brilliant colors and striking pattern and seem to court observation by alighting conspicuously on the upper surfaces of leaves.

Family MEMBRACIDAE

Abundant, especially in half-over-grown clearings, where eggs, immature and adults spend their lives on a single stem, attended by their guardian and shepherd ants. The forms are beyond description in weird outlines, hooks, humps, knobs, blades, handles, pillars, curved projections forming absurd initials (in one case E L). All this elaborate protection is inexplicable, as no creature seems to feed on them, and most of the adults have the advantage of eyesight, leaping powers and wings. Seventy-four species have been recorded, in an unpublished monograph by Maud D. Haviland, of which twenty-six have proved to be new to science. Almost all are tended by ants of various species.

Family CERCOPIDAE

Frog-hoppers are common, a few abundant, many dull-colored, others brilliant, but not as a rule of unusual shape. By far the dominant form is *Tomaspis ruber*, black with two conspicuous yellow cross-bands, which always alights and remains in full view.

Family CICADIDAE

While not abundant as collecting goes, cicadas are aurally the most dominant form of insect life, their voices rising above all other sounds during the dry season. They range from very large to small forms, some with curious ocelli, others very like our northern cicadas. A common form with brown wings is frequently attracted to our lights in the evening, while others come more rarely. The "six-o'clock bee" of the colonist is a cicada, and is so-called because of its regularity of utterance each evening. Some of the jungle cicadas call from high up in the trees with vibrations of tremendous power, either single notes, or two, separate at first and merging into a true trill. Only once have I found cicadas gathered in any numbers, in May, when I observed thirty-six on the stems of a low Dalli sapling.

Five birds and a lizard are known to feed upon cicadas in the research district.

Family PSYLLIDAE

Two mutilated specimens have been taken from the mouth of a tiny frog. A few living species collected, one being an interesting gall-forming type, causing malformations which harbor a number of parasites and inquilines whose bionomics are very complicated.

Family APHIDIDAE

This family is mentioned to emphasize its almost complete absence, its place being taken by membracids. Only two true aphids have yet been found at Kartabo. They are not rare on the sea-coast.

Family ALEURODIDAE

The commonest member of this small group is an active larva which crawls over the leaves completely concealed by an astonishing growth of long flaxen filaments which project in every direction. Other nymphs are tended by ants. Winged adults are seen more rarely flying about among the leaves and low bushes of the jungle.

Family COCCIDAE

Coccids are legion, both unattached and in intimate association with ants and other insects. Sometimes a tree-trunk will be almost completely covered with small earthen mounds, each of which is a stable built for a coccid by some species of ant. Large brilliantly colored ones are found in the nest of *Azteca*, but for the most part they are dull of hue, or covered with a whitish exudation of wax.

Order XIII—PARASITICA

If one watches the daily ministrations of the Indians and native Boviander mothers to their children, the presence of representatives of the family Pediculidae cannot be doubted. No true lice have been found on any of the jungle mammals.

Order XIV—THYSANOPTERA

Thrips are found in every likely and unlikely place, most abundantly in flowers and under bark. On recently fallen trees scarlet immature thrips will suddenly appear in uncountable numbers under the bark, creeping out in the blazing sun of midday to go through most remarkable dances. They disappear as quickly as they come. The adults are far less numerous and fly with great difficulty, sometimes collapsing after a few inches of aerial progress.

Order XV—NEUROPTERA

Family HEMEROBIIDÆ

Only the larvae of these insects have been observed, and rather rarely, walking about on leaves in the jungle, each presenting a most curious appearance in being completely covered with bits of debris, its own old skins and the skins of the insects it has eaten, all fastened together with silk.

Family CHRYSOPIDÆ

The presence of the delicate lace-winged flies is more often indicated by their curious stalked eggs than by the larvae or imagos themselves. Often along the edge of a leaf, and sometimes on articles in the laboratory, lines of the long-stemmed, knobbed affairs are seen, each egg supported on a long, slender hair. The debris-covered larvae, encased usually in the down or hairs of plants, are found on leaves and stems in the jungle, which after a short pupal phase, also in a mound of detritus, emerge as the beautiful golden-eyed adults. These come occasionally to light, and I have reared them in stender dishes.

Family MYRMELEONIDÆ

I have seen no ant-lions in the jungle, either the pits of the larvae or the adults. The dry sand under the laboratory is pitted with their traps, and the adults are taken now and then. Others are found in the clearing near the jungle, and in old Indian cassava fields. An inch or two below the surface of the sand are found the globular sandy cocoons, the enclosing grains held tightly together with silk, and, if the adult has emerged, holding the perfect cast pupal skin.

Family ASCALAPHIDÆ

The adults, looking like ant-lions but with long, butter-fly-like antennae, come occasionally to light, and the larvae are found on leaves, looking strangely out of place. In shape they are like ant-lion larvae, but instead of being humped, they are unbelievably flat, and when resting on a bit of brown leaf are quite invisible.

Family MANTISPIDÆ

Decidedly rare in the research area. A large insect, apparently a wasp, flew from a tree-trunk directly on to my sleeve, one day. I brushed it off, and when it flew again and again at me, I retired

hastily, for a sting from a large tropical wasp often means a few days of fever. It flew after me and alighted on my gun, when I recognized it as a remarkable mantis mimicking a wasp. Not until I later pinned the insect did I realize that I had twice been fooled, and that it was in reality a member of this family, and quite unrelated to the Orthopteran mantids. I once found the remains of a mantispid in the stomach of a woodhewer, *Dendrocincla*. The larvae and pupae of mantispids have been found in cells made by spider-storing wasps in the nest of one of the *Armitermes* termites.

Order XVI—MECOPTERA

All I know of scorpion flies, *Panorpidae*, is that now and then the adults come to my light at night in the laboratory.

Order XVII—TRICHOPTERA

Caddis flies play but a small part in the fauna of Kartabo. Imagos come now and then to our lamps in the evening, but the larvae and their cases are common in the river and locally abundant in the jungle streams. Under stones in front of the laboratory are small scarlet forms living in soft linear cases made of muddy debris; also the more attractive *Helicopsyche* occurs, tiny mosaics of sand grains resembling coiled mollusk shells. In creeks farther up-river are large caddis-worms inhabiting houses of large pebbles, held together with a silken web. The larvae themselves are most remarkable, with elongated gills on the protected areas of the body, the anterior segments being hard, and the whole of most brilliant, varied colors, some individuals dominantly turquoise blue, others green.

Order XVIII—LEPIDOPTERA

The moths and butterflies form one of the most conspicuous groups of insects to be found within the quarter square mile of research area at Kartabo. The range of color and size among them is great, the size varies from minute micro-lepidopterons smaller than mosquitoes, to great moon moths, twelve to fourteen inches across the wings; the colors range from dull grays and browns through the chromatic scale to the brilliant, metallic-blue, refraction iridescence of the morpho butterflies.

The number of species observed and taken at Kartabo is very considerable, about 1215 in all, of which about 401 are butterflies and approximately 814 moths. It is probable that half as many again remain to be recorded.

Suborder HETEROCERA

For some wholly unknown reason sugaring and jacking are almost failures as regards moths at Kartabo. One hundred miles away in the Northwest District of Guiana I have had remarkable success with both methods, but at Kartabo none of the dozens of attempts has produced any but negative results. Hence the collection has had to consist of the casual individuals which flew into the bungalow on rainy nights, or whatever species were alarmed and caught in flight in the daytime, or what could be reared from larvae. Jungle moths are at the height of their abundance about mid-September. The 800 forms recorded probably represent only a very small fraction of those actually present.

The following twenty-three families of moths have been taken in the research area at Kartabo:

Sphingidae	Notodontidae
Saturniidae	Liparidae
Ceratocampidae	Melalophidae
Castniidae	Cicinnidae
Hypsiidae	Eupterotidae
Amatidae	Lasiocampidae
Arctiidae	Cossidae
Noctuidae	Dalceridae
Periopidae	Limacodidae
Geometridae	Megalopygidae
Uraniidae	Pyrolidae
Epiplemidae	Micropterygidae,

besides a host of Microlepidoptera.

These comprise in all 814 species of moths, rather unevenly distributed, as the three families of Noctuidae, Geometridae and Pyralidae include 55 per cent. of the whole number. Among the more interesting are the following:

Family SPHINGIDAE

Although fairly strong in number of species, the family of sphinx moths is not especially abundant in individuals, and these are seldom seen unless searched for in the vicinity of sweet-scented nocturnal blossoms. One form of day-flying hummingbird moth is common, and always to be found at four in the afternoon in the clearings, about the Mazaruni primroses, *Sipanea*.

Family SATURNIIDAE

Fairly well represented, mostly with conspicuous ocelli on the hind wings, and usually clad in shades of brown and dull yellows. *Therinia* is a beautiful and abundant form, resting flatly and conspicuously on jungle leaves, and closely resembling a white fungus patch or the excrement of a bird.

Family CERATOCAMPIDAE

Three species only have been collected, two of which are large and very beautiful.

Family CASTNIIDAE

Three species; one very large. The commonest often escapes observation when at rest by a very close resemblance to an orchid. On the coast this family is one of the worst sugar-cane pests.

Family HYPSIDAE

. Small, rare and very beautiful moths, superficially resembling several forms of *Rhopalocera*.

Family AMATIDAE

Sixty-odd species of these exquisite little creatures. The dominant character of the Amatids is the resemblance of many to wasps. Both in transparency of wings, constricted abdomen, coloration and especially in the habit of curving the abdomen quickly around, these so closely mimic stinging hymenoptera that we have been deceived again and again. *Correbia* is almost exactly like *Calopter* among the *Lycidae* coleoptera.

Family ARCTIIDAE

Fifty species, mostly small, but of the most exquisite colors and patterns.

Family NOCTUIDAE

Over 150 species of bewildering variety from the tiniest of little brown "millers" to the giant *Erebus* moon-moths twelve to fourteen inches across the wings. Chiefly leaf-brown and grey in color.

Family GEOMETRIDAE

Eighty species defying any résumé, so widely diverse are their extremes in color, pattern, and size. All are delicate, and many show soft shades of green. Perhaps the most common moth at Kartabo

is the exquisite *Chrysocestis*—whose wings are tiny sheets of mother-of-pearl, bordered with sealing-wax drops of gold.

Family URANIIDAE

With only two species, this family is more in evidence to the casual observer at Kartabo than a half dozen other groups with scores of forms. *Urania*, the big, green, day-flying moth, is common in migration and flying over the water every week in the year, and few days pass without a dozen or more being seen.

Family PYRALIDAE

Over one hundred small, inconspicuous moths of this vast group have been collected and named, and probably three or four times this number await more careful search.

Suborder RHOPALOCERA

Four hundred and one species of butterflies, representative of the following twelve families have been found at Kartabo:

Papilionidae	Heliconiidae
Pieridae	Nymphalidae
Danaidae	Riodinidae
Satyridae	Erycinidae
Brassolidae	Lycaenidae
Morphidae	Hesperiidae

Family PAPILIONIDAE

Aristolochiad papilios, "poison-eaters," velvety black with spots and bars of brilliant red and green, are the commonest forms of this family to be found at Kartabo. They are essentially insects of the jungle, ranging from near the ground upward, but seldom reaching the tree-tops. Occasionally individuals may be found within the clearings, drawn out of their shaded homes into the sunlight by the greater quantity of flowering plants to be found in the open spaces. These butterflies are slow-flying, the wings moving continuously, never sailing with set wings, they are fearless of man, and usually alight in the most conspicuous spots on the tops of leaves. The caterpillars are mottled greens, grays and browns, sometimes marked with white or yellow. A few species as they sit in their usual diurnal position in the center of a leaf, resemble the excrement of birds.

Representing another group of papilios is the southern form of

our northern swallow-tail, or "orange dog," although it is by no means common. It is a swift and powerful flier, always found in clearings, and never within the jungle.

The family, as a whole, ranks among the common insects to be found within the research area.

Family PIERIDAE

This family is rather well represented, especially in forms frequenting the clearings. At certain times of the year, large migrations of male butterflies of the genus *Catopsilia* occur at Kartabo and many other places in British Guiana. These migrations are practically always to the northwest of Kartabo, and sometimes continue for days, the number of insects taking part mounting into hundreds of thousands. Occasionally, for a short time, the direction of the migration may be reversed.

These butterflies are capable of long sustained flights, usually flying when on migrations from two to six feet from the ground, following closely the contour of the country, over rivers, through clearings and, when the jungle is reached, flying straight across the top, and continuing onward over the roof of the forest.

The larger pierids,—yellows, oranges and whites, in appearance and habits much like our northern cabbage butterflies,—inhabit the open clearings. One or two species of this group have adopted the colors of some of the jungle butterflies and have left their clearing homes for the shaded jungle. Instead of possessing broad wings and the usual self colors of the pierids, these butterflies (*Dismorphia*) have long narrow wings, white, bordered and barred with dark greenish brown above, and with a broken brilliant orange band on the lower surfaces of the hind wings. In these forest forms, the flight has also changed, and has become slower, simulating the flight of the species they most closely resemble, especially the danaid *Aeria*.

Family DANAIDAE

The southern form of the monarch is occasionally found in the research area at Kartabo, but it is by no means common. It inhabits clearings, and caterpillars have been found feeding upon *Costus spicatus*.

Ithomiids are the butterflies most typical of the forest about the research station. The greater number of forms are bright yellow and brown, with black bars and patterns; some have opaque wings and others are quite transparent. Their flight is slow, the wings

moving continually, gently and softly. These are found in low and mid-jungle, seldom ascending to the tree-tops or upper portions of the jungle. Small glades and trails within the forest are their favorite spots, where they flit slowly about, their brilliant colors flashing forth as the sunlight falls upon them. Many of these butterflies have social sleeping habits, numerous individuals assembling each evening on one or two bushes, and spending the night close together. Other species have peculiar dancing habits.

These, as we have demonstrated again and again, are distasteful to monkeys, lizards and most birds, and as they are more numerous in individuals, they have served as models for many more edible, but less abundant, butterflies. So close is the resemblance, down to most minute details, that in many cases it requires careful examination with a hand lens to distinguish between them.

Family SATYRIDAE

Satyrs and wood-nymphs are common, many species being found, living entirely within low jungle and near the jungle floor. All are dull browns and grays and blues, while in a few species the wings are wholly transparent. Almost all are characterized by the possession of bright-colored ocelli on the hind wings. The transparent species never alight anywhere but near the ground, immediately vanishing from sight.

Family BRASSOLIDAE

Equally as common as the Morphos are the insects belonging to this family. The most abundant forms are owl butterflies (*Caligo*) with dull purplish upper surfaces of the wings, and mottled gray, white and brown under surfaces, ornamented with a large bluish ocellus on each hind wing. These butterflies are crepuscular and delight in flying up and down trails within the jungle, and along the edges of clearings. Caterpillars are often found, and are especially common on the long leaves of banana.

A number of other species are found within the research area, always in the jungle, and possessing sombre shades of brown and buff above, occasionally with brilliant patches or bands of bright blue, yellow or purple. The undersides of the wings are covered with intricate patterns of grays and whites and browns.

Family MORPHIDAE

The most brilliantly colored butterflies are the Morphos. Dur-

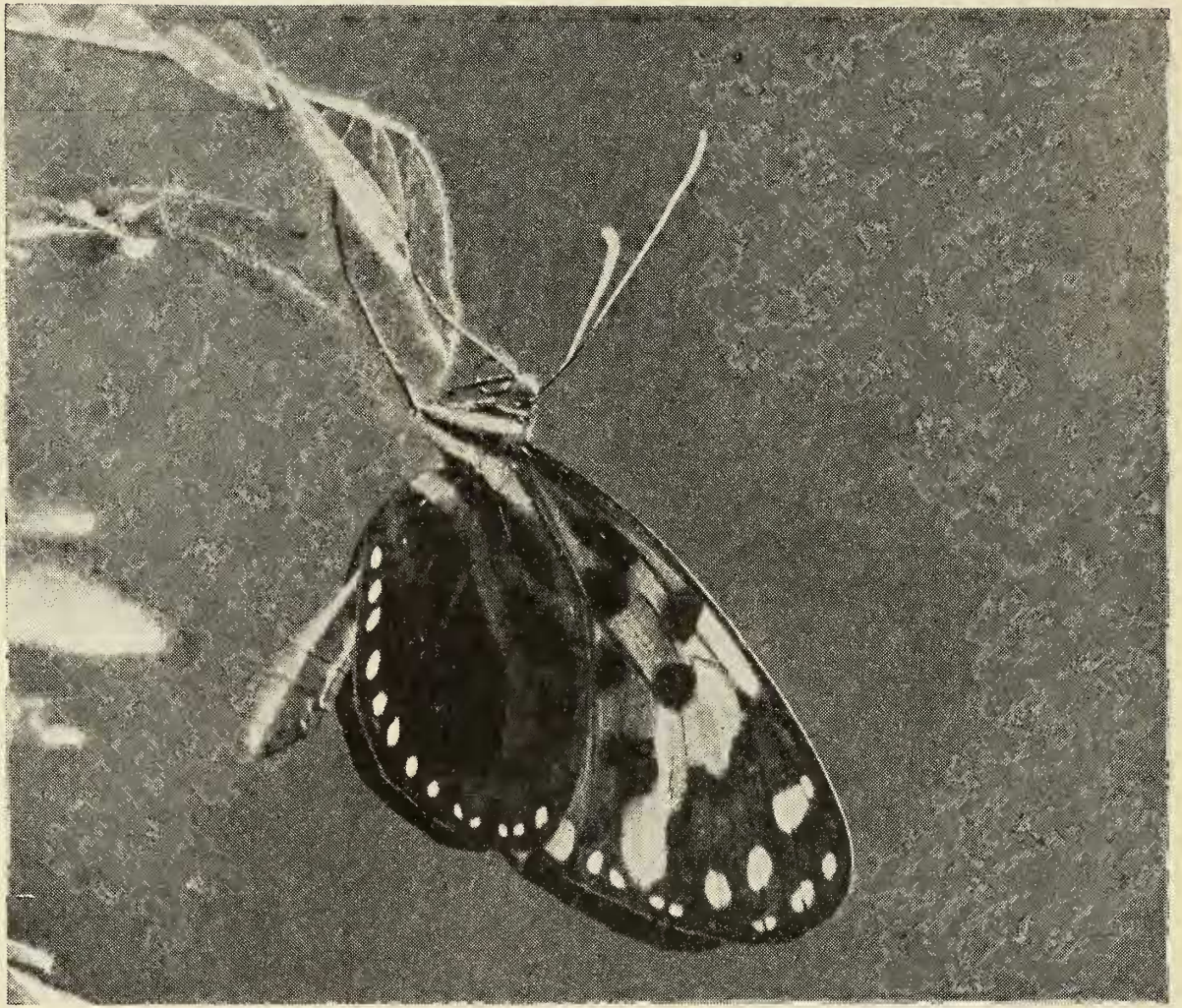


Fig. 10. A sleeping Danaid butterfly, *Melinaea mneme* Linn.
Photograph by William Beebe.

ing the beginning of the rainy seasons *Morpho menelaus* is especially abundant. These magnificent insects may be seen flying through the jungle, preferring trails and glades and especially open spaces above streams, and occasionally entering the clearings. During flight the wings move slowly, the insect progressing in undulating waves, the crest of each wave from six to fifteen feet beyond the preceding. This species is seldom seen above mid-jungle.

Occasionally, high in the air, over the tree-tops, may be seen the brown and yellow females of *Morpho hecuba*. Unlike the more brilliantly colored species these seldom descend to the ground or low jungle, but remain in and above the tree-tops.

Three broods of morpho caterpillars have been found. All were found in daylight, congregated on the upper surfaces of leaves suspended over the waters of the river. All the caterpillars were brilliant scarlet, with pale green saddles and cross-patterns, and extremely conspicuous.

Family HELICONIDAE

This essentially neotropical group is quite well represented at Kartabo. Like the ithomiids, which they closely resemble in form and often in pattern and color, they are insects of the jungle, seldom entering clearings, preferring trails and shaded glades. One species resembles the common yellow, brown and black ithomiid, forming with a similarly colored but rare danaid, a mimicry ring. The forms most common within the research area are black, with red cross-bars on the wings, or irregularly marked and spotted with yellow, blue and red. A very small, yellow-brown heliconid, belonging to the genus *Eueides*, is very often found along the edge of the clearing, resembling a common nymphalid, *Colaenis*, in form and color, but distinctly smaller in size.

Family NYMPHALIDAE

Many of the tree-top forms belong to this group, and they are also found distributed through the jungle. Their colors and forms are varied and no generalizations can be made as to their appearance. Some of the commoner forms are among the most beautiful insects to be found at Kartabo, such as *Ageronia*, the Calico, with its indescribable mottling of grays, blues and browns, or *Nessaëa*, brilliant green beneath, and orange, black and shining blue above.

Family RIODINIDAE

Seven species only have been found of this small family, the most abundant and striking being *Helicopsis*, a small moth, pale yellow and black, with gold bespangled hind wings drawn out into six pairs of tails.

Family ERYCINIDAE

This group is represented by many species, but a comparatively small number of individuals. Mimicry of other forms is evident, and some of the resemblances, especially among those mimicking satyrids, are quite remarkable. These butterflies are small to medium in size, found entirely within the jungle, especially near trails and in low jungle. In coloration they vary from yellow and dull grays and greens to brilliant orange, barred and mottled with black and white, but on the whole are of bewildering variety of form and color. In alighting the erycinids have one habit in common,—they always rest on the under surfaces of leaves.

Family LYCAENIDAE

This family is only moderately represented by about thirty-five forms at Kartabo within the research area, and is only fairly common in individuals. The hair-streaks and blues that are to be found, are confined to the jungle and to the edge of the denser thickets, and are most easily captured as they fly near trails.

Family HESPERIDAE

The Skippers form one of the most abundant families to be found within the research area. They are especially common within the clearing and along the edge of the jungle. Their color is usually brown, with spots of white or buff, or bold splashes of yellow.

Within the clearing, the most common form is a small mottled gray and white species of *Hesperia*. It is always present and seldom flies more than three feet above the ground. This skipper, unlike most of the other representatives of its group, flies rather slowly, the wings moving continually as the butterfly threads its way among the twigs and branches of the smaller bushes near the ground. When alighting the wings are held half way between vertically and horizontally, and after one or two soft wavings, their position changes to vertical, and the upper surfaces face and touch each other.

A number of hesperid caterpillars have been found feeding upon the leaves of the giant bamboos about the station.

Order XIX—COLEOPTERA

About forty families of beetles have been recognized in the quarter square mile under observation.

No detailed classification has yet been attempted and the number of families will undoubtedly be greatly increased when this is done. The number of species of beetles far exceeds that of any other group of insects. A conservative estimate of the coleopterous fauna of the quarter square mile, based on a composite of the number suggested by several entomologists, is ten thousand, of which over half would be divided between the three families of Chrysomelidae, Staphylinidae and Rhyncophidae, the flower beetles, rove beetles and weevils.

The food content of many hundreds of birds' stomachs gives a similar indication of the great abundance of beetles, as more than one hundred and thirty species of birds have been found feeding on

them, Hymenoptera being second, having entered into the diet of ninety-five species.

Yet as far as individuals goes there is no comparison with ants, wasps, termites or flies, all of which infinitely outnumber the beetles. But in number of species the latter far excel the other families.

Family PASSALIDAE

These big, black, slow-moving beetles are the commonest inhabitants of dead logs. At least half a dozen species have been taken without any special search. They would well repay careful study, because of their interesting social and family life, the adults and larvae living together and communicating by audible squeaks.

Family SCARABAEIDAE

This is one of the most interesting and numerous families. Especially the Coprides, which come in numbers to carrion, in bewildering variety. They range from the tiniest of tumble-bugs to giant purple and glowing copper scarabs. Thirty-five species came within a few days to carrion which we exposed. The other tribes of this family, including the cockchafers, so-called June bugs and cetonids are all found in abundance. The latter especially can be collected in numbers about recently felled trees.

Family CICINDELIDAE

Tiger-beetles are not very abundant, apparently not being well adapted to life in the dark humid jungle. In the clearings, however, they are found, and scores of "doodle-bugs" make their tunnels in the compound of the laboratory.

Family CARABIDAE

Ground beetles are not nearly as abundant as in the north. The most abundant is a good-sized black species with large jaws, common in pits and eaten by Bufos. In the compound big yellow and black bombardier beetles are abundant at certain seasons, shooting out a spray over one's fingers which in odor and stain is exactly like iodine. On the sand of the beach tiny nocturnal carabids mimic young mole crickets in arenaceous coloring and in their palmate fossorial front tarsi. Under bark is a favorite place for many carabids.

Family HALIPLIDAE

Minute, rather slow-swimming beetles, quite common in pits and artificial water-holes.

Family DYTISCIDAE

Abundant both in species and individuals. A dozen species were taken in a small tub of water sunk in the jungle.

Family GYRINIDAE

Much more common in the river than in the jungle creeks or pools. When not gyrating some species spend the heat of the day in pairs on the shady side of stakes well above the water.

Family HYDROPHILIDAE

Found both in the river and in the jungle, but less common than the dytiscids.

Family PSELAPHIDAE

Three species of these small interesting beetles have been taken in the nests of termites.

Family STAPHYLINIDAE

Rove beetles form one of the three dominant families of coleoptera, at least in point of numbers of species and individuals. They are found under every condition where coleoptera live, especially on decaying animal matter, fungi and under fermenting bark. They show extreme adaptation to the various environments in color, size and shape, and offer an almost untouched field to the neotropical coleopterist.

Family HISTERIDAE

Although always with the rounded, shining black characters of the family, these beetles differ widely in habitat and the mere glimpses I have had of their larvae show that the diversity in appearance and habits is very great. Carrion, fungi and rotten fruit attract the greatest numbers.

Family SILVANIDAE

These come to lights and several times have been found under bark.

Family EROTYLIDAE

Fungi appears to be the almost exclusive haunt of these ornate beetles, where they are found in numbers, varying widely as to size but usually of a red color.

Family COCCINELLIDAE

Lady-birds, like some other tropical creatures, far transcend

our northern species in brilliance of pattern and coloring, but almost all are small.

Family DERMESTIDAE

Various species quite unlike our northern pests are found infesting our insect collections if not carefully watched.

Family BYRRHIDAE

A remarkable assemblage of small beetles whose antennae, head and legs fit so perfectly into grooves that they appear to be merely lines etched on a curved, perfectly smooth surface.

Family PTINIDAE

Small beetles occasionally coming to light; these have been found in dry bark.

Family LAMPYRIDAE

Fireflies are abundant in species and individuals at certain seasons, and glow worms are occasionally found. There is great variety in intensity and in color of the light. Still more numerous are beetles (*Telephorides*) similar to our soldier beetles of the north, and large black and yellow wide-elytraed *Lycides*. These latter are often very abundant about recently felled trees.

Family CLERIDAE

Small, brightly ornamented beetles, seldom seen.

Family ELATERIDAE

One of the dominant families in size and numbers. On a recently fallen tree many species can be taken as they zoom past, looking for a place suitable for their eggs. The giant lightning bugs which illumine the jungle are click beetles. In a new camping place a flash-light or lantern will often draw fifteen or twenty, which come streaking like meteors through the trees.

Family BUPRESTIDAE

The two first sentences under Elateridae apply with equal force to these insects. They are the wasps of the beetle world, nervous, quick, wary and of brilliant color and pattern. They fly swiftly to dead tree-trunks and run with equal facility over the bark. The largest of all the Kartabo beetles,—the “sun-bee” of the

natives and "chee-ree-gib-bee-puh" of the Akawai Indians is a monster iridescentally metallic buprestid, three inches long.

Family TENEBRIONIDAE

A very large and diversified family, living chiefly in dead wood and fungi. A large black species inhabits the roof of the laboratory.

Family CISTELIDAE

Fewer in numbers than the preceding, but resembling it in general appearance and habits.

Family MORDELLIDAE

Common at certain seasons, resting on the leaves of low bushes in clearings. Brilliant in coloring and equally efficient in leaping, running and flying.

Family RHIPIDORHINIDAE

Medium-sized beetles with narrow elytra, plumose antennae, and variegated patterns, on flowers and leaves.

Family CANTHORIDAE

No adults have been taken, but the larvae have been occasionally found attached to bees.

Family BRUCHIDAE

A great variety of beetles come under this family, some large and tenebrionid-like, others small, with marvellous patterns, resembling some of the active bark weevils.

Family CHRYSOMELIDAE

The number and variety of these flower beetles is unbelievable. Only a comparatively few species are taken in numbers, while many of the forms are uniques, seen only once during five years of collecting. The dominant characters are smallness of size, the marvellous colorings and patterns, and a universal habit of death-feigning when alarmed. The variety of situations in which they are found suggests a corresponding diversity of habits and conditions of development. Most of those living under bark are lichen- and wood-hued and of paper flatness, while those on leaves may be extremely convex and glowing like living gems. Most creatures refuse them as food, but cuckoos, toads and organisms with a corresponding catholicity of taste devour them greedily.

Family CERAMBYCIDAE

The tropics are famous for their wonderful longicorns, and Kartabo sustains this reputation. While well to the fore in numbers, this family probably excels in diversity of form and pattern. Some are tiny, with a negligible, almost thread-like body, larger ones have the elytra covered with hieroglyphics which appear almost decipherable; others have immense tufts of parti-colored hairs on the antennae or the hind legs, while the giant long-legged *Acrocercus* is in a class by itself.

In mimicry alone this family is supreme, and I occasionally take forms which in shape, size, color, pattern and, most astonishing of all in action, are perfect imitations of bees and wasps.

By far the commonest, and almost the only form which ever comes to light, is the green and yellow *Chlorida festiva*.

A coleopterist could spend a life-time at Kartabo, studying this family alone, and have but little time hanging heavily on his hands.

Family ANTHRIBIDAE

Fairly common, but difficult to define and no definite notes have been made upon their haunts or habits.

Family CURCULIONIDAE

One of the three dominant families, if not actually in first place itself in point of species. Weevils are not conspicuous to the casual walker through the jungle, but in week after week of collecting, the weevil boxes are the ones which soon fill to overflowing. Again we find rather an enormous number of species represented by one or a very few individuals, than any great preponderance of beetles themselves. Giant palm weevils and others equally large with inexplicable furry beaks covered with dense auburn hair are at one extreme, while the small wasp-like, active bark beetles represent a wholly different type. Mother-of-pearl weevils which close up and drop to earth at a touch are the most abundant on the leaves of the undergrowth.

Family BRENTHIDAE

These are usually bronzy beetles with enormously elongated thoraxes. The largest species are found under bark, never doing anything as far as my brief observations go. They are slow walkers and do little to avoid capture.

Order XX—STREPSIPTERA

Family STYLOPIDAE

Twice only have we observed a member of this parasitic group imbedded between the segments of the abdomen of a wasp.

Order XXI—DIPTERA

Very large collections of two-winged flies have been assembled, but only a beginning has been made in specific identification. They are present in enormous numbers, but under ordinary circumstances are not conspicuous. On a walk through the jungle, only here and there is a fly seen resting on a leaf or hovering motionless in mid-air. At the laboratory there is almost never a fly on the dining table, and at our work a few midges in early morning during the rainy season are all that interfere. One species of biting fly alone is ever troublesome, and this in extremely small numbers, easily killed, and in the rainy season only. At the most two or three may attempt to bite during a long walk.

But at a bit of decayed meat, or a sudden growth of fungi or oozing sap, hosts of flies will gather at once. Also, several sweeps of a fine-meshed net among the jungle undergrowth will often take hundreds which, in the dim light, were invisible to the eye.

Out of seventy-one families of Diptera in the world, forty-two, or about 60 percent have been already detected in the quarter of a square mile of jungle under observation, and future search should bring the total up at least to sixty families, as that number should reasonably occur, according to geographical distribution.

Family CECIDOMYIIDAE

These minute insects are taken in the sweep net both in clearings and the jungle and their galls are abundant, seen on weeds, bushes and the smaller twigs of trees.

Family MYCETOPHILIDAE

A few have been observed on fungus. Doubtless a careful search would reveal large numbers.

Family CULICIDAE

Many species of mosquitoes are found in the jungle, but only under abnormal and very unusual conditions are they ever troublesome. Ordinarily no nets are ever used in the sleeping tents and

one may sit quietly for hours in the midst of a swamp without hearing a mosquito or being bitten. The unprecedented drought of the spring of 1924 resulted in the formation of large numbers of isolated pools near the rapids of the Cuyuni in which vast numbers of mosquitoes developed before the beginning of the long delayed rains. These spread over the country, became infected by the Indians, and for the first time we all suffered from brief attacks of malaria. Most of the natives have chronic fever but make no attempt to combat it.

Giant, brilliantly colored mosquitoes breed in the bromeliad water, and go piping through the jungle, sounding like young birds calling for food.

Family SIMULIIDAE

"Black flies" are very rare at Kartabo and their place is taken by the following family.

Family CHIRONOMIDAE

The larvae of these midges form an important item in the food of the smaller shore fishes, and the imagos emerge at intervals in countless swarms. These aquatic species confine themselves, however, to the boats and stellings; they do not bite, and seldom fly more than a foot or two above the water or shore.

Tiny black midges are sometimes troublesome for an hour in early morning and late afternoon.

Family PSYCHODIDAE

The tiny moth flies are locally very common. A large species is abundant about out-houses, and a very small grey-haired form has been reared from fungus.

Family DIXIDAE

Inconspicuous flies, rather rare, long-legged and buffy in color, taken in sweep-net in jungle trails.

Family TIPULIDAE

Crane flies of all sizes are common, especially in the dark cavities of hollow stubs, under over-hanging banks and at lights in the evening.

Family BIBIONIDAE

Not rare, the commonest being a large smoky-winged species with red thorax hovering about fallen logs.

Family RHYPHIDAE

Small, mosquito-like flies of this family are occasionally taken in jungle trails.

Family STRATIOMYIDAE

An abundant group, some very large, and many with bizarre shapes and brilliant colors. They are found over water and on the damp bark of trees. Some have a transparent window at the base of the abdomen, giving the appearance of a slender, wasp-like pedicle. A yellow-faced species has a circular body, purple, touched with grey.

Family LEPTIDAE

Medium-sized flies, with marbled or otherwise variegated wings, common in the jungle, chiefly about decayed fruit or rotten wood.

Family TABANIDAE

Abundant in a great variety of places, including some very large species. The yellow, band-winged "deer-fly" is the only fly which ever bites one along the jungle trails. The beautiful pale-green *Tabanus mexicanus* is occasionally found in the laboratory at light, but is seldom seen outdoors.

Family THEREVIDAE

Medium-sized flies, closely resembling small robber flies and with similar habits.

Family BOMBYLIIDAE

Bee flies are not common, but very beautiful, heard and seen hovering in mid-air, often close to the jungle floor. They are so wary that it requires the most careful stalking to capture them.

Family ACROCERIDAE (CYSTIDAE)

The commonest species resembles a good-sized metallic bee, with enormous eyes and a proboscis so long that it extends back twice the length of the entire body.

Family MYDAIDAE

Very large flies resembling asilids, but with slow flight among the undergrowth.

Family ASILIDAE

One of the largest groups of flies and by far the most conspicuous. A dozen species can be seen on a single walk along a jungle trail. They rest on leaves waiting for their prey to come in sight, and return to the same position to devour it. Their diet includes almost all kinds of insects, with flies and bees, and especially trigonid bees, in the majority. Robber flies are of all sizes and colors, some being almost mosquito-like in their delicacy, others closely resembling in size and color and hairiness the largest *Xylocopa* bees, doubtless an authentic case of aggressive mimicry.

Family EMPIDAE

A hundred of these tiny flies may be taken at times in the jungle with a few sweeps of the net, but to the non-Dipterist they form but a slight visible proportion of the life of the jungle.

Family DOLICHOPODIDAE

These come second to the asilids in general visibility. A few steps along any jungle trail is sure to reveal one of these long-legged, iridescent-bodied flies running over the surface of a leaf, or waiting quietly for the small creatures which form its prey. I have never seen them in any other situation.

Family PHORIDAE

Abundant around dead animal matter and in mid-air in trails. Wingless phorids are common on fungi and as guests of army ants.

Family PIPUNCULIDAE

Tiny flies with enormous heads and eyes are captured in sweep-nets in the deep jungle.

Family CONOPIDAE

The commonest species are remarkably perfect mimics of wasps, and the advantage of this is very evident when we know that the females lay their eggs on the bodies of various hymenopters.

Family SYRPHIDAE

Flower flies are relatively less abundant than several other groups, but all are dazzlingly brilliant or decorated with bright yellow. They are chiefly to be found hovering in mid-air in clearings.

Acalyptrate MUSCIDAE

This hodge-podge of flies is represented by a vast number of widely varying forms, some iridescent, others with beautifully marbled wings, while some have legs of enormous length. Many species are found walking about on sap-covered bark laying their eggs in crevices. Drosophilids, as elsewhere, are abundant on over-ripe fruit, and hosts can be taken in a few sweeps of the net in the jungle.

The following are a few of the families which have been distinguished:

Sciomyzidae	Trypetidae
Geomyzidae	Sapromyzidae
Drosophilidae	Ortalidae
Psilidae	Agromyzidae
Tanypezidae	

Family ANTHOMYIIDAE

These are small editions of house flies which are abundant about decaying animal remains.

Family TACHINIDAE

A few of these big, hairy flies have been taken in the jungle, but the majority of the species and individuals have been hatched as parasites from caterpillars and chrysalids of lepidoptera.

Family DEXIIDAE

Several flies, closely resembling Tachinids, conform to the characters belonging to this family.

Family SARCOPHAGIDAE

Very abundant on all decaying animal matter but never coming into the laboratory or tents. This is inexplicable, as thousands may cover a dead animal or bird which has been put out a few yards away, to attract vultures, and yet no member of this family is ever found on our dining or work tables. Some appear exactly like northern house flies, others are large and marked with beautiful patterns.

From the body of a small antbird in a state of advanced decomposition, I took, within a period of fifteen minutes after exposure, twenty-two species and eleven hundred and forty individual flies, the majority of which belonged to this family.

Family OESTRIDAE

The larvae are frequently found under the skin of wild animals, and are sometimes so abundant on nestling birds that they cause death. Imagos, sometimes of very large size, are captured now and then. The largest measured over an inch and a half in length. I, and several members of the staff, have had "mosquito worms" deposited in the shoulder or behind the ear. Our love of science fell short of allowing them to develop!

Family HIPPOBOSCIDAE

These strange flies are not uncommon on certain wild mammals. I have taken forty deadulted individuals from a small deer. A large collection of feather flies has been made from birds—the gallinaceous forms almost always having several swimming through and over the plumage.

Family STREBLIDAE

Winged flies of this remarkable family are taken occasionally on bats.

Family NYCTERIBIIDAE

These strangest of flies, wingless and highly specialized for their limited environment, are found only in the fur of bats, and each species of bat appears to have its particular form of nycteribid.

Order XXII—SIPHONOPTERA

Family PULICIDAE

Fleas have been found on a number of wild animals, while "jiggers" are abundant on the sandy floors and yards of Indian benabs.

Order XXIII—HYMENOPTERA

As far as any adequateness of treatment is concerned I might just as well say that ants, wasps and bees are present in vast numbers in the quarter square mile of jungle, and then turn to the next group of organisms.

I have made only the most casual attempts to divide them into families, and no group has as yet been studied completely by any competent Hymenopterist.

Although quite inadequate for any thorough, modern, taxo-

nomic treatment, Sharp's general arrangement of Hymenoptera in the *Cambridge Natural History* has proved satisfactory for my present purpose. So I have constantly adhered to it, merely raising a number of his subfamilies or tribes to the more modern view of families. Out of forty of his families, neotropical in range, I have found about thirty at Kartabo.

Family TENTHREDINIDAE

Saw-flies are not nearly as abundant as they are in the north, while the relatively great abundance of individuals of the species is more like northern organisms than is usual in the tropics. The commonest is a small species which crawls slowly about on the leaves of the jungle, while at times a yellow-bodied form is extremely numerous, flying slowly along close to the jungle floor. The function of this family is most certainly usurped in the research area by some other group.

Family CYNIPIDAE

These little insects and their galls are abundant but no notes have been made upon them.

Family PROCTOTRYPIDAE

Numbers of species of these very minute wasps have been bred from butterfly eggs. The only notes made have been on the number of individuals in each egg, and the sex. From eleven to twenty-five proctotrypids find nourishment and the wherewithal for growth and development in each lepidopterous egg, and in several dozen carefully observed instances there has never been more than a single male, who fertilizes all of the females as they emerge.

Family CHALCIDIDAE

Found everywhere in bewildering variety, a few of remarkably large size, most beautifully sculptured and patterned, and in color from buff, yellow, red and blue to the most intense iridescence. Over fifty percent of all the lepidopterous caterpillars taken are parasitized with these or closely related forms.

Families ICHNEUMONIDAE, BRACONIDAE

I have bracketed these two families because of the similarity in superficial appearance in the field and the identity of habits of the

more conspicuous forms. On a single long walk I have taken about fifty individuals, which would prove to be about evenly divided between the two families. They are found flying low through the underbrush searching leaf after leaf, both upper and under sides, for the prey which they parasitize. The majority of the larger forms of both families have yellow- and black-banded wings.

Family STEPHANIDAE

A small family of insects resembling the above.

Family EVANIIDAE

Not rare and most remarkable in shape, some appearing as if the abdomen had been amputated, this portion being reduced to a tiny knob protruding from the upper part of the thorax while others have enormously elongated abdomens which are parti-colored and held aloft.

Family PELECINIDAE

A half dozen specimens with greatly elongated abdomens have been taken of these insects.

Family CHRYSIDIDAE

Fairly common insects clad in magnificent reticulated armor of glittering blue-green.

Family MELIPONIDAE

This family is the most characteristic group of Tropical bees. It includes the *Melipona* and *Trigona*, mostly small black or brown insects about 6 mm. long. These are stingless, social bees, usually building mud or waxy nests in logs, in the ground, in odd corners of buildings or even in termite nests. One large colony had apparently experienced considerable difficulty in working over the nest carton and maintaining their entrances against the termites. Both entrances extended several inches beyond the normal circumference of the nest, giving evidence of a long struggle before the termites gave up and allowed the entrances to remain open.

The open mud nests were subject to enlargement by the addition of further hanging galleries until the colony reached its maximum size and swarming occurred. These nests were further characterized by the presence of bee-bread and honey pots, maintained in place by short, strong braces of wax and mud.

A considerable variation in pugnacity was found among the different colonies; the one described above would swarm out angrily and bite viciously if the nest were even jarred by a blow against the tree on which it was located. Other colonies could be examined at close range without apparently disturbing the inhabitants.

Some twenty odd species have already been described from Kartabo.

Family XYLOCOPIDAE

Seven species of these wood borers have been found at Kartabo and vicinity. They usually proved quite wary and were difficult to collect. The higher flowers were their favorite haunts, adding still more to their safety. One species reached a length of 35 mm., the females being black and the males mostly brown. In several other species, both sexes were black with hairy, ferruginous thorax.

Family CERATINIDAE

Few individuals of this family of carpenter bees were noted at Kartabo. Possibly three species. They are very small in comparison to the other family of borers, the Xylocopidae.

Family BOMBIDAE

In number of species, this family was poorly represented, only two having been described as yet. Even these species are open to question, it being possible that they are identical. The individuals are very numerous, however, and can be collected from any plant or shrub along trail or road, in cleared ground or on river banks. They are dull, slow of flight, and easily captured.

Family AUGOCHLORIDAE

About seven species of these little iridescent bees of the genus *Halictus* and the genus *Augochlora* have been noted. They are true tunnel makers, preferring the soft earth of the side of a pit or bank for their homes. Although they may use a common gallery into the earth, each bee has its own branch, this family being truly solitary.

Family ANTHOPHORIDAE

Seven species of *Centris* of the subfamily Centrinae are plentifully represented in the Kartabo region. Possibly the most numer-

ous species were large brown bees, invariably found around rivers. They seemed to enjoy basking in the sunshine on logs or planks; whirling in erratic flight about a passing boat or canoe; or investigating, with much interest, the paddler's hat or perhaps even his insect net. Their white-marked faces gave an odd impression of intelligence, well borne out by their elusiveness when pursued and their delight in taunting the pursuer by whirling past him with terrific speed.

Two species of *Melitoma*, also belonging to this family, were found.

Family MEGACHILIDAE

Four species of *Megachile* and at least one of *Coelioxys* have already been described. Those of the genus *Megachile* are the true leaf cutters and build nests or burrows lined with sections cut from leaves.

Family EUGLOSSIDAE

This family of long tongued bees is without doubt the most striking family found around Kartabo. Possibly fifteen species or more have been collected. Brilliant reds, greens and blues, combined with yellow and black, solid greens and solid blues and purples, present an assortment of color that cannot be rivaled. They possess an extremely rapid wing beat, enabling them to maintain themselves stationary in the air, while collecting their food from flowers. They are solitary, building in the ground or even in termite nests.

Including other unclassified specimens with the groups considered above, one is justified in believing that from one hundred to one hundred and twenty species of bees have already been collected from the Kartabo region. Those listed above are the most common families, others occurring rarely.

Family EUMENIDAE

The small potter wasps are not nearly as abundant as a northern hymenopterist would expect them to be. Several species build their nests in the laboratory.

Family VESPIDAE

This is the largest family of wasps and hornets, or marabuntas,

as the natives call them. Their nests, large and small, are seen along the trails and in the deep jungle, near the ground and in the tree-tops.

Family MUTILLIDAE

The wingless, velvet wasps are present in numbers and there is an abundance of species. The wingless females are more often seen than their mates, and are gay with spots of gold and scarlet.

Family SCOLIIDAE

A widely varying and numerous group, some big, yellow and hairy, others small and iridescent green. I have found two of the extremes of size parasitizing larvae of Scarabaeidae, so it is reasonable to suppose that many intermediate types have the same habits.

Family SAPYGIDAE

Only a few of these have been collected, closely resembling members of the preceding family.

Family POMPILIDAE (PSAMMOCHARIDAE)

Very numerous, many of large size with black or orange wings, others grey, with banded wings. Some are very tiny and stick their mud cells to the beams of the laboratory. They tirelessly hunt dead and living leaves, trunks and twigs for their spider prey.

Family SPHEGIDAE

These strong mud-daubers are abundant, and certain of their number are among the largest of Kartabo hymenoptera, one specimen reaching an extreme length of two and one-half inches, and with a sting which would surely send a human victim to bed with a week of fever.

Family LARRIDAE

Moderate to large wasps, most of which nest in the jungle floor, while others build beautiful nests of plant-down on the under sides of leaves. Their colors are greatly varied, and they are only fairly abundant.

Family TRYPOXILONIDAE

The most familiar families of wasps at the laboratory are little black fellows which we call vial wasps, from their habit of seizing

upon every empty horizontal vial they can find, to divide it into little cells and stock with spiders. The group is small and only occasionally is one taken in the jungle.

Family BEMBECIDAE

These wasps have the untropical character of being only fairly numerous as to species with exceedingly abundant individuals. Every area of sunny sand in a jungle trail or clearing is sure to have dozens buzzing about or digging frantically, throwing up little spurts of sand as they sink from view. Persons new to the jungle have to be assured that, although these big, yellow wasps love to buzz alarmingly close to one's face, they are never known to sting without strong provocation.

Family NYSSONIDAE

A small family with a few species, resembling the preceding in many characters.

Families PHILANTHIDAE, CRABRONIDAE

Two unimportant Kartabo families of small, yellow-banded wasps, more abundant during the dry than the rainy seasons. Their habits vary widely and I have found them nesting both in the ground and in hollow twigs.

Family FORMICIDAE

One's first walk through the jungle, as well as the last day of many years' residence, results in the same conclusion, that ants by far outnumber all other groups of insects. But not until Prof. William Morton Wheeler had spent several months collecting them, did I realize the great number of species represented in our quarter square mile. Even in the much more restricted area of the laboratory compound, he found every genus of fungus-making ant known in the world, and on a single tree only one hundred and fifty feet away from the laboratory, Prof. Wheeler collected ninety-six species of these insects.

The abundance and remarkable habits of the army ants *Eciton*, and leaf-cutting ants, *Atta*, have led me to write several essays about them.³ But scores of others are equally interesting and would repay

³Jungle Peace, Chapter IX; Edge of the Jungle, Chapters III, VII, VIII.

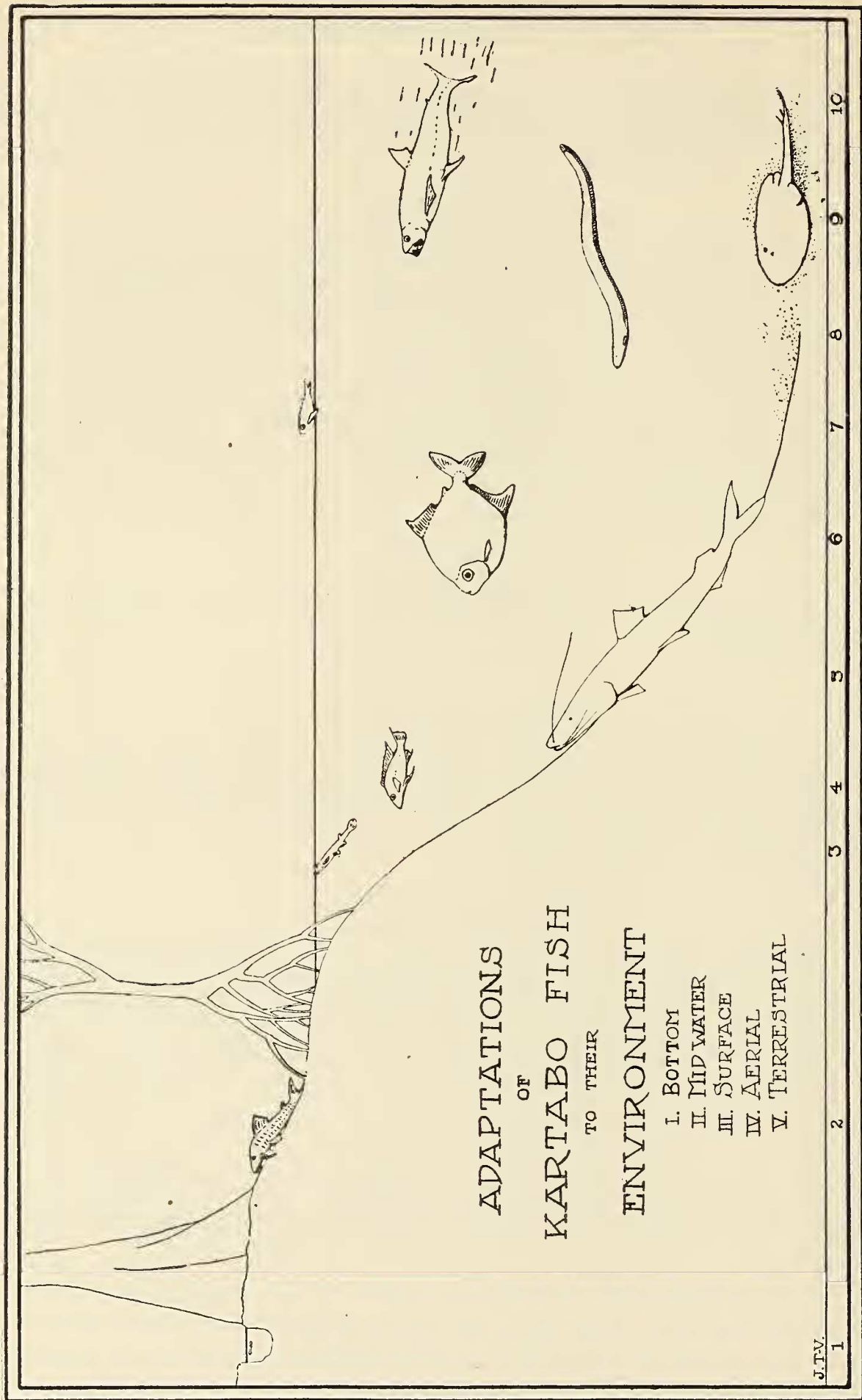


Fig. 11. Adaptions of Kartabo fish to their environment.
Drawing by John Tee-Van.

months of study. The most conspicuous ant in the deep jungle is *Ectatomma tuberculatum*, which waits, solitary and patiently, on leaves for the approach of victims. Up and down the trunks travel the giant black *Neoponera* ants, the pain and swelling of whose sting last for many days. One fact, from the host which comes to the eye of the casual observer, is the specialized diet of some of these Ponerine ants, one of which feeds solely upon giant termites of the genus *Syntermes*.

Several times a year army ants clear our laboratory of all roaches and tarantulas, while, on the other hand, leaf-cutters render hopeless all our attempts at gardening—destroying both flowers and vegetables. Tiny red ants make it necessary to keep all fresh specimens on swinging shelves, but aside from this no ant disturbs or injures our possessions.

CHORDATA or VERTEBRATES

Within the small area set aside at the Tropical Research Station at Kartabo for intensive study, I have recorded eight hundred and eighteen species of vertebrates, almost exactly 60 per cent. of the total number so far known from the whole Colony of British Guiana. This may be taken as showing either the wide distribution of vertebrate forms of life and their abundance in a small area in the tropics, or it may indicate the very great number of species still to be discovered when intensive investigation similar to mine in my quarter of a square mile, is applied more widely. The truth lies probably between the two.

As the area under consideration is only one-three hundred and sixty thousandth ($1-360,000^{\text{th}}$) of British Guiana, this record is rather remarkable. It is as if there were found within half the area of the New York Zoological Park, or one quarter of Central Park, New York City, more than half of all the vertebrate animals of New York and Pennsylvania combined.

Among the invertebrates, the insects, and more especially ants, are by far the dominant forms; with vertebrates, birds are ahead to such an extent that there is relatively no second place. This is distinctly shown in the following table, together with other side-lights upon the general aspect of the back-boned animals of this limited area.

<i>Vertebrate Classes</i>	<i>No. of Species</i>	<i>Percentage of Whole</i>	<i>Number Indi- viduals</i>	<i>Dominant Visually</i>	<i>Dominant Vocally</i>	<i>Dominant in Color</i>	<i>Ex- tremes in Size</i>	<i>Danger to Man</i>
Fish	150	18.6%	1	5	5	3	2	2
Am- phibians	37	4.5%	2	3	2	4	5	5
Reptiles	93	11.4%	4	2	4	2	3	1
Birds	464	56.5%	3	1	1	1	4	4
Mammals	73	9 %	5	5	3	5	1	3

THE FISH OF KARTABO

The study of the fish life in the research area at Kartabo has been made doubly delightful by constant reference to Dr. Carl H. Eigenmann's "Fresh-water Fishes of British Guiana." An additional source of interest lies in the fact that the Station is situated at the junction of the only two great rivers in the Colony which Eigenmann did not explore so that every capture or note which we make is certain to contribute a wholly new fact to our knowledge at least of the distribution of forms.

Within the few hundred yards included in the shallow water along the shore of our research area, and in one or two adjacent creeks, we have secured one hundred and fifty species of fish, rather more than one-third of the entire number secured by Dr. Eigenmann in his exploration of the Colony at large.

While the low mentality of fish is undoubtedly a fact, yet this is compensated by the interest of their great diversity of form and size, marvellous beauty and remarkable habits, and perhaps most of all by their vital suggestions of past evolution and the vivid evidence of evolution going on today, which they express in their bodies and their life habits.

As in the jungle, so the tropical waters teem with unexpected and strange organisms, and there is no level or niche left unexplored or unoccupied by one or more species of fish. I shall mention only a few of the many interesting aspects of fish life about the Station. In extremes of size we find schools of little sword-finned minnows close inshore, measuring less than an inch in length, while farther out, great lau-lau catfish swim about, brobdignagian bull-heads six to twelve feet in length, with grinning mouths two feet wide. They

will occasionally take the hook but put up no more fight than would a barrel of cement. The largest fresh-water fish in the world and one of the most gamey also inhabits Guiana waters, the arapaima, which reaches a length of fifteen feet and a weight of over four hundred pounds. We have, however, not yet taken it at the Research Station. The flesh of all these fish is most delicate.

Many of the fish are very beautiful, but on the whole there is hardly an average of greater brilliancy of pigment than in the fishes of temperate waters. Scarlet eels and golden catfish with fins of flame-color are astonishing when they swim up through the brown water; and many-colored ocelli or eyed spots are rather common both on fins and bodies. As to variety of form there is no end. To take mouths alone, there is the elongated tube of the pipefish, the swordfish-like needlefish and the halfbeak with its minute upper mandible and enormously lengthened under jaw. Most frightful looking fish come up in the seine, such as the silvery biara or dog-toothed fish, with teeth so long that they pass clear through the head and project into the water above, yet which is a fish wholly innocuous; on the other hand a meek appearing sunfish is in reality the notorious perai, one of the most dangerous of all fishes. Nothing more hopeless can be imagined than to be attacked by a school of these razor-toothed little fiends.

The sand gobies, when frightened, flatten out on the bottom, and draw over themselves a mantle of color identical with that of their background; the comical green- and black-banded puffers, on the contrary, distend themselves with air into a taut, skinny, inedible ball, and float out of reach upon the surface until danger is past.

The fish about Kartabo show three important radiations; first, intrusions from the salt water of the open sea, fifty miles away by water line; second, aerial attempts, and third, terrestrial trials. As unexpected intrusions from the sea we find the gobies and the young gar or needlefish is also essentially marine. Most remarkable are the sting rays, two species of which have deserted salt water and inhabit our rivers. The last ocellated ray which we caught on a set line, gave birth to five young rays in the boat; in an aquarium the little rays flapped slowly about on the sandy bottom and the back of the mother.

The four-eyed fish is also essentially a lover of salt or brackish water but occasionally it enters the fresh waters about Kartabo. It is, however, as an invader of the air that it holds greatest interest,

the upper part of the eyes being modified for atmospheric vision, while it appears unable to dive more than a foot or two beneath the surface. The second aerial aspirant is the fresh-water flying fish, built rather on the lines and method of operation of a hydroplane than an airplane, as it rises with a rush and slithers along the surface, its deep keel usually cutting a tiny furrow as it goes.

The piscine land invaders are of extreme interest, both on account of their individual specializations and their evolutionary significance. When a pool forms after a heavy rain, deep within the jungle, or on a hillside well away from water, it soon contains fish as well as tadpoles and whirligig beetles; fish not descended with the rains, as the old legend has it, but which have scrambled and leaped and finned their way from the abundance of their element in the great rivers to this meagre, temporary cupful of water in the midst of a host of terrestrial dangers. Why the impulse comes to them, or to them and not to many others, we cannot even imagine.

Other land-loving fish are the primitive hassas or armored catfish, which come out at low tide and flip about the mud, regardless of sun or drought. These and the marsh eels are most unsatisfactory aquarium fish, for they are continually climbing out and seeking the seclusion of dusty corners. I may here only mention the astounding electric eel with its double dynamos of living flesh, and the nurse fish, whose young find sanctuary by the half hundred in the mouths of their parents.

While there is no lack of fish, large and small, near the Station, yet the least successful method of capture is by rod and line. This is due to several reasons, chief among which is the low visibility of the brown jungle water, combined with the abundance of natural food which the fish find ready at hand. Fish hold an important place in the diet of the Indians about Kartabo and they are skilful in shooting them with bow and arrow, poisoning and trapping them. They know the exact edibility of the various species and of the poisonous parts of specific ones such as the liver of the large catfish. They have names for almost all and even distinguish between forms which bear a very close superficial resemblance.

Our collections have been made almost altogether by means of set lines and seining.

Within the research area I have a record of forty-seven species of vertebrates feeding on fish, of which about half probably devour no other forms of life. If several more thousands of stomachs could

be examined this number would be considerably increased, especially among the fishes themselves. These enemies of fish vary from creatures like the snakebird, kingfisher and dolphin which seem fundamentally adapted for a piscine diet, to the kiskadee flycatcher which has only recently taken to fishing.

The piscivorous vertebrates of Kartabo are as follows:

Fish	12	Birds	26
Amphibia	1	Mammals	3
Reptiles	5		

The remarkably general distribution among varied orders of vertebrates is well indicated in the following list:

Class PISCES

Order	Genera
Batoidea	<i>Potamotrygon</i>
Nematognathi	<i>Paulicea</i>
	<i>Brachyplatystoma</i> (3 sp.)
	<i>Ageniosus</i>
Heterognathi	<i>Serrasalmo</i>
	<i>Hydrolicus</i>
	<i>Cynopotamus</i>
	<i>Hydrocynus</i>
Symbranchii	<i>Symbranchus</i>
Percomorphi	<i>Plagioscion</i>

Class AMPHIBIA

Cystignathidae	<i>Leptodactylus</i>
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Class REPTILIA

Boidae	<i>Eunectes</i>
Ilysiidae	<i>Ilysia</i>
Colubridae	<i>Hydrops</i>
Elapidae	<i>Micrurus</i>
Crocodilidae	<i>Caiman</i>

Class AVES

Ralliformes	<i>Heliornis</i>
Lariformes	<i>Phaetusa</i>
	<i>Sterna</i> (2)
	<i>Rhynchops</i>

Gruiformes	<i>Mycteria</i>
Ardeiformes	Hérons (11)
Pelicaniformes	<i>Phalacrocorax</i>
	<i>Anhinga</i>
Accipitriformes	<i>Pandion</i>
Coraciiformes	Kingfishers (5)
Passeriformes	<i>Pitangus</i>

Class MAMMALIA

Marsupialia	<i>Chironectes</i>
Carnivora	<i>Lutra</i>
Odontoceti	<i>Inia</i>

Class PISCES

Order BATOIDEA

Family PRISTIDAE

Sawfish Rays: There are four records of sawfishes caught at Kartabo before our first arrival, and twice during our absence twelve-inch individuals have been secured by Indians in creeks. This is distinctly a marine intrusion, with the precedent of what is probably the same species ascending the Mississippi for a considerable distance.

Family DASYATIDAE

Sting Rays: Strictly marine rays are found abundantly in the lower Essequibo, but from Bartica up, two species of fresh-water rays occur, one rather commonly. Five miles higher, above the rapids and from there for many miles up river these are numerous and a constant source of danger to gold and diamond seekers. The mucus of these fresh-water forms seems more virulent than that of the sea rays. Both species have been taken at Kartabo, and the young to the number of five been born alive in captivity. They are carnivorous bottom feeders, taking worms, small fish, shrimps and drowned organisms.

Order NEMATOGNATHI

Fresh-water catfish are especially characteristic of the Amazon and Guiana regions. Thirty-four species have been found at the Station, divisible into five families.

Family SILURIDAE

Twenty species belong under this family. Among them are the common bottom or mid-water forms, one of which, a *Pimelodus* locally known as Larima is actually abundant. These are of small or moderate size, but in this same genus are the giants of these waters, such as *Brachyplatystoma*, the lau-lau, which ranges from a length of not uncommonly seven feet, to reputed giants of twelve feet.

The smaller catfish are mostly bottom feeders and embrace in their diet worms, small fish, mollusks, shrimps and hosts of drowned terrestrial insects. The giant mid-water forms feed altogether on medium-sized fish, and spend most of their time well out from shore where they can be caught on strong set lines at night. Occasionally however they come close in and can be heard grunting and booming among the rocks and mangroves.

Family HELOGENIDAE

A single, small, mottled catfish of this family is occasionally taken in jungle creeks.

Family PYGIDIIDAE

Two species, one quite eel-like in shape, also occur in creeks.

Family CALLICHTHYIDAE

Three species of these interesting armoured catfish occur, all feeding on muddy vegetable debris.

Family LORICARIIDAE

Seven species of this family show two general types of structure, one of which, *Loricaria*, is exceedingly flattened for a strictly bottom life, while *Plecostomus* is triangular in transverse section and is almost as much at home on the mud of the shore as in the water. All feed on vegetable debris and small organisms. *Plecostomus* is eaten by the small river cormorants.

Order HETEROGNATHI

Family CHARACIDAE

In number of forms and variety of types the Characins of Kartabo may be compared with the Passerine group of birds. We have collected fifty-one species, comprising nearly forty per cent of the entire fish fauna. These are distributed through seventeen families.

Many are very small and inconspicuous looking fish, and among them are the most abundant shore forms. None are true bottom dwellers but are found in mid-water and on the surface, chiefly in creeks or along the shore. A few are brilliantly colored. Several have enormously developed canine teeth and are aquatic wolves; the notorious Peraí has moderate teeth but is the most dangerous, fiercest fish here, if not in the world. Its closest relative is a harmless vegetarian. The fresh-water flying fish are Characins, skimming for long distances along the surface. A few of the larger species form the chief food of the Indians. Worms, insects, shrimp and other fish form the principal items of diet of these fish.

Order GLANENCHELI

Family GYMNOTIDAE

The eels of Kartabo number eight species distributed unequally among four subfamilies. All are interesting forms but the electric eel is preeminent, and specimens over five feet in length have been taken. We have occasionally had a shock transmitted by the water when swimming but any danger is imaginary. It feeds on shrimp, tadpoles, fish and other small organisms and except when small is found in the open river. The other eels are inhabitants chiefly of jungle creeks and several are brilliantly colored. They feed on shrimp, caddis-worms and insects.

Order SYMBRANCHI

Family SYMBRANCHIDAE

This eel in appearance and habits resembles so closely the limbless amphibian *Typhlonectes* that we considered it as such for a long time. It lives in swamps and in the mud along shore, and forms the chief food of coral snakes and of two of their mimics. It feeds in turn on fish and crabs.

Order ISOSPONDYLI

Family ENGRAULIDAE

Two small species of *Stolephorus* are found along the shore, one very abundantly. They are small, silvery fishes with such delicate, deciduous scales that the least touch dislodges a shower. A species of *Lycengraulis* is considerably larger than the two preceding. The food is minute insects and entomostracans.

Order MICROCYPRINI

Family POECILIDAE

Five interesting small fish represent this minnow-like family. *Rivulus* is the most terrestrial of all the Kartabo fish fauna, and is found in isolated rain pools deep in the jungle, a half mile or more away from the river. *Anableps* is essentially a salt-water form, the Four-eye adapted equally well to see under water as well as in the air. Three small ones among the mangroves are all we have on record at the Station.

The Sword-finned Minnow, *Tomeurus*, is a very abundant and persistently littoral form, with the male showing most remarkably specialized sexual characters. Entomostracans form their principal food.

Order SYNENTOGNATHI

Family BELONIDAE

A small gar-like fish is very rare at Kartabo.

Family HEMIRHAMPHIDAE

A curious fish, with enormously elongated under jaw, and a short stump of an upper jaw, lives along the shore and feeds on spiders, gnats and small mollusks.

Family ESOCIDAE

There is one record of a *Tylosaurus*.

Order LOPHOBANCHII

Family SYNGNATHIDAE

A small pipe-fish is not uncommon. All the specimens secured have been females with the ventral brood pouch filled with eggs more or less advanced in development.

Order PERCOMORPHI

Family CICHLIDAE

An interesting family of which seven species are present. *Geophagus* is common along shore, the parents sheltering the young fish in their mouths in time of danger. *Crenicichla*, a very brightly colored carnivorous form, lives in mid-water.

Family SCIAENIDAE

Three species, one of which, *Plagioscion*, is very common and an important food-fish.

Family POLYCENTRIDAE

One small, vertically flat, black, changeable colored fish of the deep jungle is occasionally found.

Family GOBIIDAE

Three very common forms of sand gobies. One, an *Eleotris* with most remarkable color changes, spends much time in the open air or in small tide-pools. Two sand gobies are found intensively associated, resembling each other in size, shape, general sandy pattern, carnivorous habit, yet belonging to very distinct genera—*Evorthodus* and *Awous*.

Order HETEROSOMATA

Family PLEURONECTIDAE

A small species of flounder is rare and very local in distribution. Native fishermen say that it was first found here four years ago, so is evidently a recent invasion. Nothing has been found in its stomach but sponge spicules and Chironomid larvae.

Family SOLEIDAE

Two species, of which one, a small flounder of the genus *Achirus*, is somewhat more common than the other, all the specimens being under three inches in length.

Order PLECTOGNATHI

Family TETRADONTIDAE

A small, green- and black-banded puffer is common along shore. It also occurs as a surface feeder out in the open river and is especially numerous at the mouths of jungle creeks. It is an omnivorous feeder, and is fed upon by *Ardea cocoi*.

FISH STOMACH CONTENTS

Sponge Spicules—	<i>Pimelodus clarias</i> <i>Achirus fasciatus</i>
Worms—	<i>Potamotrygon hystrix</i> <i>Leporinus arcus</i> <i>Poecilurichthys abramoides</i> <i>Gymnotus carapo</i>
Oligochaetes—	<i>Hemidoras carinatus</i> <i>Leporinus nigrotaeniatus</i> <i>Pristella riddlei</i> <i>Gymnotus carapo</i> <i>Eigenmannia virescens</i> <i>Gymnorhamphichthys hypostomus</i>

Fish stomach contents—continued

Leeches—	<i>Stolephorus surinamensis</i>
Mollusks—	<i>Pimelodus clarias</i> <i>Megalodoras</i> sp. <i>Hyporhamphus roberti</i> <i>Colomesus psittacus</i>
Entomostracans—	<i>Stolephorus surinamensis</i>
Daphnia—	<i>Stolephorus surinamensis</i> <i>Tomeurus gracilis</i>
Cyclops—	<i>Hemidoras carinatus</i> <i>Stolephorus surinamensis</i>
Isopods—	<i>Sternopygus macrurus</i>
Shrimps—	<i>Potamotrygon hystrix</i> <i>Pimelodus clarias</i> <i>Pimelodus ornatus</i> <i>Chalcinus rotundatus</i> <i>Hydrolicus scomberoides</i> <i>Electrophorus electricus</i> <i>Gymnorhamphichthys hypostomus</i> <i>Stolephorus surinamensis</i> <i>Plagioscion auratus</i> <i>Crenicichla alta</i>
Crabs—	<i>Pimelodus clarias</i> <i>Symbranchus marmoratus</i>
Crustaceans—	<i>Pimelodus clarias</i> <i>Pimelodus ornatus</i> <i>Leporinus alternus</i> <i>Poecilurichthys abramoides</i> <i>Stolephorus surinamensis</i> <i>Tomeurus gracilis</i> <i>Colomesus psittacus</i>
Chelifera—	<i>Pimelodus clarias</i> <i>Hemidoras carinatus</i>
Spiders—	<i>Leporinus alternus</i> <i>Chalcinus rotundatus</i> <i>Tomeurus gracilis</i> <i>Hyporhamphus roberti</i> <i>Colomesus psittacus</i>
Mites—	<i>Hemidoras carinatus</i> <i>Leporinus nigrotaeniatus</i> <i>Eigenmannia virescens</i>
Millipedes—	<i>Pimelodus clarias</i> <i>Leporinus nigrotaeniatus</i>

Fish stomach contents—continued

- Dragonfly Larvae— *Sternopygus macrurus*
Gymnorhamphichthys hypostomus
Plagioscion auratus
- Orthoptera— *Colomesus psittacus*
- Roaches— *Potamotrygon hystrix*
Rhamdia sebae
Chalceus macrolepidoptus
Cynopotamus essequibensis
- Hemiptera— *Hemidoras carinatus*
Leporinus arcus
Creatochanes caudomaculatus
Hyporhamphus roberti
- Moths— *Chalcinus rotundatus*
- Caterpillars— *Potamotrygon hystrix*
- Caddis Larvae— *Hemidoras carinatus*
Leporinus arcus
Sternopygus macrurus
Eigenmannia virescens
Colomesus psittacus
- Diptera— *Rhamdia sebae*
Pimelodus ornatus
Hemidoras carinatus
Creatochanes affinis
Creatochanes caudomaculatus
Holobrycon pesu
Gasteropelecus sternicla
Sternopygus macrurus
Stolephorus surinamensis
Rivulus stagnatus
Tomeurus gracilis
Hyporhamphus roberti
Plagioscion auratus
Geophagus surinamensis
Evorthodus breviceps
- Chironomids— *Pimelodella cristata*
Pimelodus clarias
Pygidium guianensis
Stolephorus surinamensis
Geophagus jurupari
Achirus fasciatus
Colomesus psittacus
- Neuropterous Larvae— *Pygidium guianensis*
Chalceus macrolepidotus

Fish stomach contents—continued

Electrophorus electricus
Sternopygus macrurus
Gymnorhamphichthys hypostomus
Stolephorus surinamensis

Beetles—

Hemicetopsis macilentus
Leporinus nigrotaeniatus
Moenkhausia grandisquamis
Creatochanes affinis
Poecilurichthys abramoides
Holobrycon pesu
Chalcinus rotundatus
Carnegiella strigata
Gasteropelecus sternicla
Myloplus rubripennis
Cynopotamus essequibensis
Gymnotus carapo
Eigenmannia virescens
Eleotris amblyopsis

Ants—

Pimelodus clarias
Leporinus alternus
Tetragonopterus chalceus
Moenkhausia grandisquamis
Pristella riddlei
Creatochanes affinis
Creatochanes caudomaculatus
Poecilurichthys abramoides
Holobrycon pesu
Chalceus macrolepidoptus
Chalcinus rotundatus
Carnegiella strigata
Myloplus rubripennis
Gymnotus carapo
Sternopygus macrurus
Rivulus stagnatus
Hyporhamphus roberti
Crenicichla lugubris
Colomesus psittacus

Muddy Debris—

Potomotrygon hystrix
Pimelodus clarias
Callichthys callichthys
Hoplosternum thoracatum
Corydoras punctatus
Plecostomus plecostomus
Hemiancistrus braueri
Xenocara gymnorhynchus

Fish stomach contents—continued

Ancistrus sp.
Loricaria cataphracta
Loricariichthys griseus
Loricariichthys stewarti
Electrophorus electricus
Geophagus surinamensis
Geophagus jurupari
Eleotris amblyopsis

Vegetable Matter—

Pimelodella cristata
Hemisorubim platyrhynchos
Doras granulosus
Hemidoras carinatus
Trachycorystes obscurus
Hemicetopsis macilentus
Bivibranchia protractila
Curimatus spilurus
Curimatus schomburgki
Prochilodus rubrotaeniatus
Anastomus anastomus
Laporinus nigrotaeniatus
Laporinus alternus
Poecilurichthys abramoides
Holobrycon pesu
Brycon falcatus
Myloplus rubripinnis
Myloplus rhomboidalis
Myleus pacu
Electrophorus electricus
Gymnotus carapo
Gymnorhamphichthys hypostomus
Rivulus stagnatus
Hyporhamphus roberti
Geophagus surinamensis
Colomesus psittacus

Seeds—

Doras granulosus

Algae—

Anisitsia notata
Leporinus fasciatus
Cretochanes affinis
Myleus pacu
Symbranchus marmoratus
Eleotris amblyopsis
Colomesus psittacus

Fish—

Potamotrygon hystrix
Paulicea lutkeni

Fish stomach contents—continued

- Brachyplatystoma rousseauxi*
- Brachyplatystoma vaillianti*
- Ageniosus marmoratus*
- Serrasalmo rhombeus*
- Hydrolicus scomberoides*
- Cynopotamus essequibensis*
- Hydrocynus cuvieri*
- Symbranchus marmoratus*
- Plagioscion auratus*
- Crenicichla lugubris*
- Eleotris amblyopsis*

Tadpoles—

- Electrophorus electricus*

Class AMPHIBIA

In the quarter mile of research area I have found thirty-seven certainly identified species of Amphibians, together with eight additional species represented only by tadpoles or other insufficient material. The thirty-seven species are grouped in two orders and seven families. One of the most remarkable facts about this Class is the total absence of Urodeles. As far as we know not a single newt or salamander is found in the entire Colony.

Apoda, the first order, with a single family Coecilidae, is represented in my restricted area by only one species, *Siphonops annulatus*, a legless, earthworm-like amphibian. It is a burrowing form, apparently very rare, and in its structure a most remarkable combination of ancestral and specialized characters.

The comparative relationships of the six families of Anura, the toads and frogs, is shown in this table:

	Families	No. of Species	Relative number of Individuals	Relatively dominant Visually	Relatively dominant as to Color	Relatively dominant as to Style	Relatively dominant Aurally
1	Pipidae	2	6	6	6	6	6
2	Bufonidae	3	4	1	5	1	3
3	Hylidae	11	2	3	1	3	1
4	Cystignathidae	11	1	2	3	2	4
5	Engystomatidae	4	5	5	4	5	5
6	Ranidae	5	3	4	2	4	2

Order ANURA

Family PIPIDAE

The classic Surinam Toad is confined to the Guianas and the adjacent portion of Brazil, but heretofore has been found only on the coast and not in the interior. Up to the present two individuals only of *Pipa americana* have been recorded from the research area, one full-grown. In March 1924 I made a search for Pipas in the pool where a small species was found two years preceding, and although it was almost dried up I discovered five, one large female, a smaller male and three small ones. Later in the year several breeding females were found by Dr. Emerson, and the species confirmed as a second, small member of the genus, *Pipa aspera*.

Family BUFONIDAE

Three toads inhabit this area, two of them common. One of these, the Marine Toad, might be termed familiar, for it lives about, and even in and under the laboratory, and offers little objection to capture and handling. Its catholicity of taste in diet is astonishing, quite as much so as its almost complete lack of enemies.

Were mankind an important factor in this area, this toad would be of the utmost value, for it feeds on the most noxious insects. In the stomach of a medium-sized individual over seven hundred *Attas* or leaf-cutting ants were found, besides fifty other ants, millipedes, centipedes and scorpions. The very young toads devour ticks, mites and *bête rouge*. The deep-throated, continuous roar of these frogs is heard off and on throughout the year, but is at its height during the first part of the rainy seasons. The sound carries over a mile across the water. The Marine Toad excels all other Kartabo amphibians in size, reaching a weight of one and one-half pounds, and in vocal power is surpassed only by the Giant *Hyla*.

Family HYLIDAE

The tree-toads form one of the most characteristic and interesting tropical families of amphibians. Eleven species have been found in the research area. Probably one-third as many more remain to be discovered when the tree-tops and the ultimate leaves of the deep jungle have yielded their batrachian secrets. The most brilliant colors are found here and voices which far outdo all other sounds of the night. *Hyla rubra* is the familiar of this group, coming into the laboratory and depositing its eggs in our aquariums and vivariums.

Family CYSTIGNATHIDAE

In this family are included eleven frogs varying in form from the amazing huge-headed *Ceratophrys* and the nine-inch tadpole of *Pseudis* to the tiny *Leptodactylus minutus*. Those of the genus *Leptodactylus* are strong, fierce creatures, never reconciled to captivity, cannibals on occasion, with many strange habits such as uttering an appalling scream when captured.

Family BREVICIPITIDAE

Four anomalous species, chiefly walkers, and except *Atelophus*, swamp burrowers, extremely difficult to find. All are rare.

Family RANIDAE

Two little leaf-walkers are common and noisy in the rains, the male *Dendrobates* carrying the tadpoles about upon his back. The green Guiana Bull-frog is found along the shore and also deep in the jungle.

ENEMY AND PREY ECOLOGY

Enemies of Amphibians

Twenty species of vertebrates have been found to prey on Amphibians:

Two fish—*Plagioscion* and *Serrasalmo*.

Four amphibians devour their own kind, three species of *Leptodactylus*, while the tadpoles of *Phyllomedusa* aggressively attack and devour other species of tadpoles.

Seven species of snakes, *Herpetodryas* (2 sp.), *Bothrops* (2 sp.), *Liophis*, and *Xenodon* (2 sp.), feed on seven species of *Anura*.

Five birds, *Europyga*, *Theristicus*, *Ardea*, *Cochlearius* and *Urubitinga*.

Two mammals, *Lutra* and *Nasua*.

AMPHIBIAN STOMACH CONTENTS

Isopods—	<i>Leptodactylus pentadactylus</i> <i>Phyllobates inguinalis</i> <i>Dendrobates</i>
Scorpions—	<i>Leptodactylus pentadactylus</i>
Crabs—	<i>Hyla maxima</i>

Amphibian stomach contents—continued

Pseudoscorpions—	<i>Dendrobates</i>
Harvestmen—	<i>Bufo marinus</i>
Spiders—	<i>Bufo marinus</i> <i>Leptodactylus caliginosus</i> <i>Phyllobates inguinalis</i>
Acarina—	<i>Bufo marinus</i> <i>Bufo marinus</i> (newly hatched)
Myriopods—	<i>Bufo marinus</i> <i>Dendrobates</i> <i>Leptodactylus pentadactylus</i>
Chilopods—	<i>Bufo typhoni</i>
Insecta—	
Thysanura—	<i>Leptodactylus pentadactylus</i> <i>Dendrobates</i>
Isoptera—	<i>Hyla pardalis</i> Yellow green <i>Hyla</i> <i>Leptodactylus caliginosus</i> <i>Gastrophryne ovale</i> <i>Atelopus flavescens</i> <i>Gastrophryne microps</i> <i>Phyllobates inguinalis</i>
Orthoptera—	<i>Bufo marinus</i> <i>Hyla pardalis</i> <i>Hyla rubra</i> <i>Leptodactylus caliginosus</i> <i>Leptodactylus mystacinus</i> <i>Leptodactylus stictigularis</i> <i>Leptodactylus pentadactylus</i> <i>Phyllobates inguinalis</i> <i>Hyla maxima</i> <i>Hyla albomarginata</i>
Hemiptera—	<i>Bufo marinus</i> <i>Leptodactylus pentadactylus</i> <i>Leptodactylus caliginosus</i> <i>Leptodactylus mystacinus</i>
Membracids—	<i>Phyllobates inguinalis</i> <i>Hyla albomarginata</i>
Lepidoptera—	<i>Hyla rubra</i>

Amphibian stomach contents—continued

Diptera—	<i>Bufo marinus</i> <i>Bufo guttatus</i> <i>Leptodactylus caliginosus</i>
Coleoptera—	<i>Bufo marinus</i> <i>Bufo typhonius</i> <i>Bufo guttatus</i> <i>Hyla rubra</i> <i>Hyla boans</i> <i>Leptodactylus lineatus</i> <i>Leptodactylus pentadactylus</i> <i>Leptodactylus caliginosus</i> <i>Leptodactylus mystacinus</i> <i>Leptodactylus rhodomystax</i> <i>Phyllobates inguinalis</i>
Hymenoptera—	
Ants—	<i>Bufo marinus</i> (a. 700 Attas, 50 <i>Pachycondyla</i> .) (b. 400 Attas.) <i>Bufo typhonius</i> <i>Bufo guttatus</i> <i>Hyla rubra</i> <i>Leptodactylus caliginosus</i> <i>Leptodactylus mystacinus</i> <i>Gastrophryne microps</i> <i>Dendrobates</i> <i>Phyllobates inguinalis</i>
Hymenoptera—	
Wasps—	<i>Bufo marinus</i> <i>Leptodactylus stictigularis</i>
Vertebrates—	
Frogs—	<i>Leptodactylus pentadactylus</i> <i>Leptodactylus caliginosus</i> <i>Leptodactylus stictigularis</i> <i>Phyllomedusa bicolor</i> (tadpoles carnivorous)

Class REPTILIA

Within the research area at Kartabo I have collected ninety-three species of reptiles. Although there is no special list of the reptiles of British Guiana, in literature I find mention of one hundred and twenty forms. Hence over seventy-seven percent of this colonial total is represented in the quarter mile under observation.

Four orders are included and nineteen families, and there undoubtedly remain many more species as yet undetected.

	Number of Families	Number of Species	Relative Number of Indi- viduals	Relative Domi- nance Visually	Relative Color Domi- nance	Relative Extreme in Size	Relative Danger to Man
I—Testudinata	5	8	III	III	III	IV	—
II—Crocodilia	1	2	IV	IV	IV	II	II
III—Lacertilia	5	31	I	I	II	III	—
IV—Serpentes	6	52	II	II	I	I	I

Class REPTILIA

Order TESTUDINATA

Tortoises and turtles form a very unimportant group of Kartabo organisms, both in number of species and in specimens. Five families are represented, and eight species.

Family CINOSTERNIDAE

Cinosternum scorpioides: This species appears to be confined to Guiana and is the only South American representative of the family of our common mud turtle of New York. Only two small specimens have been found in the research area.

Family TESTUDINIDAE

Nicoria punctularia: This turtle is not rare, a half dozen being found in the creeks each season.

Testudo denticulata: This bright-colored land tortoise is the only common Chelonian in the area, and is frequently to be found wandering about in the jungle, in both dense and open growths. They reach an unusually large size, over two and a half feet in length of shell, but apparently breed when quite small. I have heard them utter musical grunts during the breeding season. Three times they have been found freshly scooped out of their shells, probably the work of an ocelot or jaguar.

Family CHELONIDAE

Chelonia mydas: Only two sea turtles have been recorded, both very small, one from below and the other just up-river from the station. The eggs of this species are common in sand banks in the Essequibo above Bartica, where they are dug out and eaten by the Indians.

Family PELOMEDUSIDAE

Podocnemis unifilis; *Podocnemis expansa*: Two young specimens and one adult of the first species, and a single adult of the second taken from the jungle creeks.

Family CHELYDIDAE

Chelys fimbriata: No mata-mata has been found within the exact research area but there are records a very short distance away to the north in Cauria Creek (two specimens reported by warder and convicts), one medium specimen east, from Kalacoon, and one from the south, just this side of Ororabo. The largest measured was eighteen inches, the smallest five and a half inches in length.

Platemys platycephala: The flat-shelled turtle is found only at the mouth of jungle creeks. Several six-inch individuals have been taken north alive.

Order CROCODILIA

Family CROCODYLIDAE

Caiman niger: The giant black crocodile of the upper reaches of the rivers of Guiana has been seen only twice near the Station. A ten or twelve foot specimen spent several days on a ledge of rocks a few hundred yards from the laboratory in 1920, and a second was observed by me on the shore some distance up the Cuyuni.

Caiman sclerops: The common crocodile of the rivers hereabouts. Four or five foot individuals nest in the trenches about the Penal Settlement, and small ones are occasionally taken in fishermen's nets near the Station. A young male three feet long and weighing five pounds had the following in its stomach:

Many small, white quartz stones,
Two large spiders,
Fifteen lizard and fish bones,
Three pieces of half-burned wood.

Order LACERTILIA

The lizards of the Kartabo quarter square mile, as in most places in the tropics, are an important group. Of the four orders of Reptilia they are first in point of number of individuals and visual dominance, second in species and brilliance of color, and third in extreme size.

Thirty-one species have been identified with certainty, varying in size from tiny geckos an inch and a half in total length to iguanas



Fig. 12. A jungle Anolis; one of the common lizards.
Photograph by John Tee-Van.

over six feet from snout to tail-tip. These are scattered through five families, of which Iguanidae has ten and Teiidae sixteen species. Twenty-one genera complete the group divisions.

While there is considerable change of color among a number of species, yet the pigmentation as a rule, both as to pattern and color, reflects the particular haunts of the various species. The ground forms, like *Mabuia*, are brown, or ruptively colored green and brown as *Ameiva*. The trunk-loving forms are grey as in *Ophryoessa*, or brown like the Geckos, and the foliage-haunting species are green, such as *Iguana*, *Polychrus*, *Plica* and some Anoli. The burrowing lizards such as *Amphisbena* are white, black or irregularly blotched.

In distribution the lizards of Kartabo range from the topmost branches of trees to several yards underground. Only one form is adaptively aquatic, although most can swim readily when need arises. The following represents in a general way the zone in which the various genera are usually found:

AQUATIC	<i>Neusticurus</i>
BURROWING	<i>Cophias</i> <i>Amphisbena</i>
TERRESTRIAL	
Jungle	<i>Tupinambis</i> <i>Iphisa</i> <i>Leposoma</i> <i>Mabuia</i>
Near Clearings	<i>Ameiva</i> <i>Cnemidophorus</i> <i>Prionodactylus</i>
ARBOREAL	
Logs and Hollow Trees	<i>Gonatodes</i> <i>Thecadactylus</i> <i>Sphaerodactylus</i>
Low Trunks and Branches	<i>Anolis</i> (brown) <i>Tropidurus</i> <i>Centropyx</i> <i>Ophryoessa</i>
Trunks, Mid-Jungle	<i>Plica</i>
Foliage, Mid-Jungle	<i>Polychrus</i>
Foliage, Low-Jungle	<i>Anolis</i> (green)
Near Creeks and Clearings	<i>Iguana</i>
IN HOUSES	<i>Thecadactylus</i> <i>Sphaerodactylus</i>

As regards occurrence no species in undisturbed environment can be said to be abundant. The numbers of the two Geckos in the laboratory itself and the young *Ameivas* and *Cnemidophorus* which scamper about the compound are adaptations to the altered conditions induced by our occupation. In the jungle the brown forms of *Anolis* and the two clearing lizards mentioned are common, but all others are occasional or rare.

ENEMY AND PREY ECOLOGY

Lizards are eaten by at least thirteen vertebrates in the quarter mile under observation, these being three snakes, nine birds and one mammal. All three species of the Cotingine genus *Attila* feed to a

large extent on small lizards, as does the Furnarian *Automolus*. The two hawks *Leucopternis* and *Gampsonyx* devour *Cnemidophorus*, as does the snake *Oxybelis*, while *Elanoides* catches *Polychrus*, *Harpagus* eats *Anolis*, and *Boa constrictor* and *Clelia* kill *Ameiva*. The coati-mundi, *Nasua*, takes lizard eggs whenever he finds them, and in one individual I found three of the rare *Cophias flavescens*.

Of the thirty species of lizards only one is a strict vegetarian. This is *Iguana*, while *Polychrus* eats berries and leaves as often as animal food. The only vertebrates so far found in a lizard's diet are *Cnemidophorus* and the spiny rat, *Proechimys*, eaten by *Tupinambis*.

LIZARD DIET

Leaves	<i>Iguana</i> <i>Polychrus</i>
Berries	<i>Polychrus</i>
Earth Worms	<i>Anolis</i>
Mollusks	<i>Thecadactylus</i>
Crabs	<i>Tupinambis</i>
Isopods	<i>Cophias</i>
Millipedes	<i>Plica</i> <i>Ophryoesa</i>
Centipedes	<i>Anolis</i> <i>Plica</i>
Acarina	<i>Thecadactylus</i>
Spiders	<i>Tupinambis</i> <i>Anolis</i>
Cicadas	<i>Plica</i>
Moth Flies	<i>Thecadactylus</i>
Mosquitoes	<i>Anolis</i>
Crane Flies	<i>Leposoma</i>
General Diptera	<i>Thecadactylus</i>
Termites	<i>Anolis</i> (two species) <i>Thecadactylus</i>
Wood Roaches	<i>Sphaerodactylus</i> <i>Anolis</i> <i>Thecadactylus</i>

Lizard diet—continued

Mole Crickets	<i>Amphisbena</i> <i>Anolis</i>
Long-Horned Grasshoppers	<i>Polychrus</i> <i>Tupinambis</i> <i>Plica</i>
Beetles	<i>Plica</i> (two species) <i>Polychrus</i> <i>Tupinambis</i> <i>Centropyx</i> <i>Amphisbena</i> <i>Thecadactylus</i> <i>Anolis</i> <i>Cophias</i>
Microlepidoptera	<i>Cophias</i>
Caterpillars	<i>Anolis</i> <i>Ophryoessa</i>
Wasps	<i>Tupinambis</i>
Ants	<i>Anolis</i> (two species) <i>Plica</i> (two species) <i>Tupinambis</i> <i>Cophias</i> <i>Thecadactylus</i>
Cnemidophorus	<i>Tupinambis</i>
Spiny Rat	<i>Tupinambis</i>

I have omitted the two most abundant species of lizards, *Ameiva* and *Cnemidophorus*, from this list, in order to demonstrate the wide range of diet of these ground saurians, and the interesting comparison of relative numbers. I have selected forty individuals of each and have ranged the items of diet in the order of their number of occurrences:

Diet of Two Lizard Species

<i>Ameiva</i>		<i>Cnemidophorus</i>	
Roaches	18	Beetles	18
Beetles	16	Grasshoppers	15
Grasshoppers	14	Spiders	13
Centipedes	9	Wasps	11
Spiders	8	Caterpillars	7
Scorpions	7	Ants	5

Diet of two lizard species—continued

Ants	7	Flies	5
Snails	4	Roaches	4
Millipedes	4	Crickets	3
Termites	4	Heteroptera	3
Mantids	3	Bees	3
Caterpillars	3	Beetle larvae	2
Diptera	3	Centipedes	2
Dipterous larvae	2	Snails	2
Crickets	2	Fruit	2
Earth worms	1	Cnemidophorus tails	1
Earwigs	1	Butterflies	1
Hemiptera	1	Membracids	1
Wasps	1	Termites	1
		Dragonflies	1
		Mole crickets	1
		Crabs	1
		Flowers	1

The breeding of the lizards of Kartabo, when charted, resolves into two unequal nodes, both occurring at the end of the rains, or the beginning of the dry seasons. April, May, October and November are the low months, and January, July and August the high ones, the latter being the month of intensest breeding by several hundred per cent. The latitude of breeding throughout the year is probably considerably greater than is apparent from my records. *Anolis* shows the following relative mensual percentages of breeding records:

January	10 per cent.	July	10 per cent.
February	20 " "	August	30 " "
March	10 " "	November	10 " "
April	10 " "	December	20 " "

The monthly distribution by genera follows:

January	<i>Anolis</i>	June	<i>Tupinambis</i>
	<i>Polychrus</i>		<i>Leposoma</i>
	<i>Iguana</i>		<i>Cophias</i>
February	<i>Anolis</i>	July	<i>Gonatodes</i>
March	<i>Anolis</i>		<i>Thecadactylus</i>
	<i>Leposoma</i>		<i>Sphaerodactylus</i>
April	<i>Anolis</i>		<i>Anolis</i>
May	<i>Leposoma</i>		<i>Polychrus</i>
			<i>Ophryoesa</i>

August	<i>Gonatodes</i>	September	<i>Plica</i>
	<i>Thecadactylus</i>	October	<i>Plica</i>
	<i>Sphaerodactylus</i>	November	<i>Anolis</i>
	<i>Anolis</i>	December	<i>Anolis</i>
	<i>Polychrus</i>		
	<i>Ophryoessa</i>		
	<i>Mabuia</i>		

Order LACERTILIA

Family GECKONIDAE

Although not especially common in the jungle yet these little vacuum-toed lizards are the first to be seen at Kartabo, for all three genera are found in the laboratory itself. The tiny *Sphaerodactylus* come commonly about our tables and creep about the glass of the windows, snatching minute insects. The most abundant species is apparently undescribed.

The larger *Thecadactylus* are nocturnal and scurry over the walls and ceiling after moths and roaches. The natives call them Gongasockas and consider them deadly not only as to bite but even to touch. A gecko larger but congeneric with the spot-shouldered *Gonatodes*, and possessing brilliant blue eyes, has proved to be new and been named *Gonatodes beebei*. In the jungle all these geckos haunt low stumps and dead logs.

Family IGUANIDAE

Twelve species represent this family, varying widely in size, coloring, habits and haunts. The commonest of all lizards are the jungle *Anolis*, confusing as to species as they are quick to the eye. They make delightful pets, soon becoming tame and leaping upon one's hand for food. In quickness and general activity they approximate birds. Those living among low growths near the leaves on the jungle floor are of various shades of brown and grey, while the *Anolis* of higher foliage are green.

Polychrus is one of the most beautiful and interesting of Kartabo lizards. It has a complete color change from brown to green, with many variations of pattern, and is adapted to its life among the mid-foliage of the jungle not only in color but in pose. It often assumes most grotesque postures with the long, slender tail draped, tendril-like, over the leaves, and one or two of its feet

sprawled in mid-air, thereby losing all semblance to a thing of life. The *Plicas* are also leaf and branch colored, but *Ophryoessa* equals *Polychrus* in perfection of adaptation to its haunts. It invariably clings lengthwise to a twig or upright dead stem, and so closely that the eye cannot distinguish between bark and saurian, while the color in both is identical. Unlike the lizards less adapted to their surroundings, *Ophryoessa* will allow one's fingers to close about it before attempting to escape, relying as much on the perfection of its protection as does a skunk or a porcupine.

Iguana is unique in being a vegetarian, and adumbrates evolution of avian flight in its leaps from tree-tops into the water of creeks.

Family TEIIDAE

Tupinambis, the Salempenta of the natives, if three times its natural size of a yard in length would be of greater danger than a full-grown crocodile. It is the nearest Kartabo suggestion of one of the fierce extinct saurians, feeding on any small mammals and birds or reptiles which it can capture and overcome, and, in addition being an omnivorous scavenger. It is a great yellow and black inmate of the jungle, living in holes and rushing about with the noise of a herd of alarmed peccaries.

Ameiva and *Cnemidophorus* are the familiars of the jungle lizards, and *Neusticurus* is found only in and about creeks through the waters of which it swims and dives skilfully. *Cophias* is a good example of a lizard with limbs so tiny that they function only when creature is moving slowly.

Family AMPHISBAENIDAE

Degeneration of the limbs is carried to an extreme in this family, which, to outward view, are serpents. Two species are found, both burrowers underground in general.

Family SCINCIDAE

Two scinks have so far been recorded, little brown, smooth-scaled, active creatures, rather rare, which produce usually four young alive at a birth, of an astonishingly large size.

Order SERPENTES

In spite of the fact that snakes are far from common, and one may tramp for miles and for days through the jungle without ever

catching a glimpse of one, I have recorded fifty-two species from the research area. These are divided into thirty-four genera and distributed along the following eight families:

Leptotyphlopidae.....	1	genus	2	species
Typhlopidae.....	1	“	1	“
Boidae.....	4	“	5	“
Ilysiidae.....	1	“	1	“
Colubridae.....	21	“	30	“
Elaphidae.....	1	“	3	“
Amblycephalidae.....	2	“	5	“
Crotalidae.....	3	“	5	“

There are eight forms of poisonous snakes, belonging to four genera. One, *Crotalus*, has been recorded only once from the quarter mile area, and a second time outside at Kalacoon, and is decidedly a stray from more open, savanna country. The noxious species range in size from the small coral snakes, *Micrurus*, to great bush masters, *Lachesis*, eight and a half feet long. The harmless species are represented on the one hand by such diminutive forms as *Atractus*, and on the other by mighty boa constrictors and anacondas, *Boa* and *Eunectes*, fifteen to twenty feet long.

In this extremity of size the snakes rank first among the orders of reptiles, as they do also in danger to man and in general brilliance of coloring. In number of individuals they come second to lizards, but again hold first place in actual number of species.

Their haunts are hardly more limited than with the lizards, the great majority being terrestrial, but with burrowing forms such as *Leptotyphlops*, *Typhlops*, *Atractus* and *Micrurus*, aquatic as *Eunectes*, or somewhat less water-loving forms such as *Helicops* and *Hydrops*, while a few snakes are adapted solely for an arboreal life, as *Oxybelis* and *Leptophis*.

No snake can be said to be abundant nor even common. Occasional is the most that can be adduced of half a dozen forms, while the records of the remainder show them to be rare or unique.

I have found only three vertebrates feeding on snakes. Two of these were snakes themselves, *Clelia* and *Erythrolamprus*, and the third an owl, *Pulsatrix*, in which case, however, both snake and bird succumbed.

Snakes include twenty-two vertebrates in their diet, two fish, eight amphibians, five reptiles, four birds and four mammals. The detailed food of twenty-three species follows:

SNAKE STOMACH CONTENTS

Earth Worms	<i>Erythrolamprus</i>
Slugs	<i>Leptognathus variegatus</i>
Spiders	<i>Xenodon</i>
Grasshoppers	<i>Xenodon</i>
Atta Soldiers	<i>Leptotyphlops</i> <i>Typhlops</i> <i>Xenodon</i>
Insects, General	<i>Tantilla</i> <i>Erythrolamprus</i> <i>Micrurus</i> <i>Xenodon</i>
Symbranchus	<i>Hydrops</i> <i>Micrurus</i>
Plagioscion	<i>Eunectes</i>
Gastrophryne microps	<i>Xenodon</i>
Leptodactylus mystacinus	<i>Liophis</i> <i>Drymobius</i> <i>Herpetodryas</i>
Leptodactylus pentadactylus	<i>Bothrops</i>
Leptodactylus caliginosus	<i>Herpetodryas</i>
Hyla rubra	<i>Herpetodryas</i>
Hyla maxima	<i>Herpetodryas</i> <i>Bothrops</i>
Bufo marinus	<i>Xenodon</i> (two species)
Bufo typhonius	<i>Xenodon</i>
Atractus trilineatus	<i>Erythrolamprus</i>
Boa constrictor	<i>Clelia</i>
Anolis	<i>Oxybelis</i>
Cnemidophorus lemniscatus	<i>Oxybelis</i>
Ameiva ameiva	<i>Clelia</i> <i>Boa</i>
Sporophila eggs	<i>Phrynonax</i>



Fig. 13.—*Corallus caninus*; a tree boa whose scales are colored green, yellow and white.
Photograph by John Tee-Van.

Snake stomach contents—continued

Domestic Chickens	<i>Epicrates</i> <i>Herpetodryas</i> <i>Xenodon</i>
<i>Pipra leucocilla</i>	<i>Bothrops</i>
<i>Nectomys</i> sp.	<i>Herpetodryas</i>
<i>Oecomys</i> sp.	<i>Lachesis</i>
<i>Proechimys cayennensis</i>	<i>Lachesis</i>
<i>Bradypus cuculliger</i>	<i>Eunectes</i>

Breeding records of oviparous snakes extend from March 27th to October 9th with no noticeable concentration about any one month or season.

As will be mentioned later, coral snake mimicry is well marked, a few specimens of *Ilysia*, *Hydrops* and *Clelia petolaria* being found in close association with a much larger number of *Micrurus mar-gravii*. The native Indians distinguish readily between the ordinary and "hot" snakes as they call the poisonous species. Occasionally a negro gets a charm which he considers an absolute safeguard and I have seen such a man handle bushmasters and fer-de-lance with almost no precautions against a bite. In a period of seven years I have had two rather narrow escapes from being bitten, but have never heard of anyone bitten anywhere in the neighboring district.

Order SERPENTES

Family LEPTOTYPHLOPIDAE

Two species of small burrowing serpents which seem confined to the interior of termite and ant nests.

Family TYPHLOPIDAE

A single species of these burrowing *Typhlops* lives in my quarter square mile of jungle, coming rarely to the surface.

Family BOIDAE

Five boas have been recorded, all of striking coloring and two reaching a large size. The green tree boa, *Corallus caninus*, is a blaze of green, yellow and white; the anaconda, *Eunectes*, the great snake of the water, is not uncommon, while the boa constrictor occupies the same position on land.

Family ILYSIDAE

The harmless, false coral snake *Ilysia* is the only representative of this family, and burrows in damp places, often in the vicinity of true coral snakes.

Family COLUBRIDAE

Like the heterogeneous avian assemblage Coraciiformes, this consists of thirty species whose diversity of habits and outward appearance are of less importance than internal structure. *Oxybelis*, long and slender, haunts the trees, while *Xenodon*, short and thick, is wholly terrestrial, flattens its head into a perfect viperine resemblance, and feeds on such noxious things as *Bufo marinus*. *Hydrops*, semi-aquatic, resembles and associates closely with *Micrurus*, and feeds on the same food, the eel *Symbranchus*. None of the colubrian snakes can be said to be common, however, in the sense that they can be found whenever searched for.

Family AMBLYCEPHALIDAE

Five small, variegated snakes of gentle disposition and conservative habits represent this family.

Family CROTALIDAE

Five really dangerous snakes complete the list of Ophidia, but all are so rare that sometimes a month of daily tramping through the jungle fails to reveal one. *Lachesis mutus*, the notorious bush-master is found always coiled in a close circle on the jungle floor. It makes no movement on being approached, but invariably one's eye is drawn toward it while still several steps away. Whether this is from a subconscious alert perception, or the unconscious detection of a delicate odor I cannot say. When this serpent is alarmed, its odor becomes unpleasantly strong and musky. The largest individual seen, which was captured alive,⁴ measured eight feet six inches in length.

The fer-de-lance, *Bothrops lanceolatus*, is much more often observed. Many small ones have been taken from the bamboo clumps around the laboratory. Of twenty-two specimens examined two were females with well-formed embryos. The arboreal green fer-de-lance *Bothrops bilineatus*, has been found only twice, the first time when one struck at my hat as I crouched under a bush.

⁴ Jungle Peace, pp. 188-195.

Class AVES

Within the quarter of a square mile of research area at Kartabo there have been observed four hundred and sixty-four species of birds. From the Colony of British Guiana as a whole there have been recorded seven hundred and sixteen species. Hence in an area one-three hundred and sixty thousandth of the whole of Guiana, I have observed about sixty-four percent of the total number of birds.

The birds of Kartabo form fifty-six percent of all the vertebrates. In number of species, and in visual, color and vocal dominance the birds stand first, yielding only to fish and amphibians in point of number of individuals, and to fish, reptiles and mammals in extremes of size. Insects are the only other organisms which stand comparison in point of general dominance.

As regards a general survey of the avifauna of Kartabo, I need add little to my chapter on the Bird Life of Bartica District (which includes Kartabo) in "*Tropical Wild Life*" pp. 91-137. The point of greatest interest in comparing the present work with this chapter is the remarkable result of intensive work in a restricted field. My notes in the earlier volume included the large collections made by professional skin collectors at Bartica, together with my notes on the whole of this region, numbering in all three hundred and fifty-one species.

As an introduction to a general survey of Kartabo birds I am reproducing from a Bulletin of the Zoological Society, an account of a Christmas bird census which will give an idea of the bird life which may be observed in the quarter mile area in a single day.

It always has been an exciting feat to see how many birds one can see within a given time or limited area. Birds of a city backyard, or a month's visitors to a bramble patch, offer a gamble which is fascinating to the human mind. I once took the greatest joy in recording seventy-six species of birds within a week, in a single tree in Brazil. This widespread human interest has been used for years with most important results by Dr. Chapman in "*Bird Lore*," whose Christmas census lists I always peruse with as much care and interest as if I had personally been a member of every party.

Mr. Inness Hartley and I once decided to make a Christmas census of the birds about our jungle laboratory at Kartabo, British Guiana, but this date occurs toward the end of the short rainy season, and their particular Christmas was a very unusual day—as

it rained from 5:00 A. M. to 5:30 P. M. The following day was almost as bad, so we had to compromise on the 27th of December, 1920.

From dawn to dark we covered considerable ground. One trip in the launch was made a short distance down the Mazaruni River, a walk was taken along the beach, two trips through the clearing about the tents and bungalow, and four trips in the jungle, all within a quarter-mile circumference. All the observations were made by Inness Hartley or myself, and we were out for about half the day—at various times from 5:30 A.M. to dark at 6:00 P. M.

On this 27th of December, 1920, the temperature was 72° at 6:00 A. M., 81° at noon, and 76° at 6:00 P. M. The morning was quiet, while the trade wind blew gently from 1:00 to 6:00 P. M. The morning was cloudy up to 11:30 A.M., while four heavy showers fell between noon and 4:00 P. M., with bright sun between them.

We observed 116 species of birds, distributed among 418 individuals. Of these a swift and a vulture may be classed as aerial; nine as water or shore birds; eighteen as inhabitants of the clearing, and the remaining eighty-seven tenants of the jungle itself. We had been studying the birds hereabouts for seven months, and yet it is so difficult to identify birds in the high trees with any certainty that we had to shoot about twenty species to be sure of them. Besides those which we identified, we each saw at least twenty or thirty more whose identity escaped both glass and gun.

Several, such as the goldbird and the giant goatsucker or poor-me-one, were identified from the call alone—this being absolutely unmistakable.

It is interesting to note that thirty-seven species or 31 per cent of the whole, were named by Linnaeus, emphasizing the interest of this region as the origin of most of the collections which he named over one hundred and fifty years ago.

No. Seen	Common Name	Scientific Name
Two	Guiana Great Tinamou	<i>Tinamus major major</i> (Gmel.)
Two	Variegated Tinamou	<i>Crypturus variegatus variegatus</i> (Gmel.)
One	Crested Curassow	<i>Crax nigra</i> Linné
One	Lesser Olive Guan	<i>Penelope marail</i> (P. L. S. Mull.)
Three	Little Chachalaca	<i>Ortalis motmot</i> (Linné)
One	Guiana Partridge	<i>Odontophorus guianensis guianensis</i> (Gmel.)
Two	Purple-tinted Pigeon	<i>Oenaenas purpureotincta</i> (Ridg.)

Bird census—continued

Six	Talpacoti Ground Dove	<i>Chaemepelia talpacoti</i> (Temm. & Knip.)
Three	Great-billed Tern	<i>Phaetusa chloropoda</i> (Vieill.)
Two	Common Tern	<i>Sterno hirundo</i> (Linné)
Two	Collared Plover	<i>Charadrius collaris</i> (Vieill.)
Two	Spotted Sandpiper	<i>Actitis macularia</i> (Linné)
One	Little Blue Heron	<i>Florida caerulea caerulea</i> (Linné)
Three	Yellow-headed Vulture	<i>Cathartes aura urubitinga</i> (Pelz.)
Three	Red-throated Caracara	<i>Ibycter americanus</i> (Bodd.)
One	Black-faced Hawk	<i>Leucopternis melanops</i> (Lath.)
One	Swallow-tailed Kite	<i>Elanoides forficatus yetupa</i> Bonn. & Vieill.
Four	Red-and-Yellow Macaw	<i>Ara macao</i> (Linné)
Five	Mealy Amazon	<i>Amazona farinosa farinosa</i> (Bodd.)
One	Dusky Parrot	<i>Pionus fuscus</i> (P. L. S. Mull.)
Eight	Purple Guiana Parrot	<i>Touit purpurata</i> (Gmel.)
Two	Black-headed Caique	<i>Pionites melanocephala melanocephala</i> (Linné)
Two	Great Gray Kingfisher	<i>Megaceryle torquata cyanea</i> (Vieill.)
Two	Little Green Kingfisher	<i>Chloroceryle americana americana</i> (Gmel.)
Two	Guiana Motmot	<i>Momotus momota momota</i> (Linné)
Two	Giant Goatsucker	<i>Nyctibius griseus griseus</i> (Gmel.)
One	White-necked Nighthawk	<i>Nyctidromus albicollis albicollis</i> (Gmel.)
Twenty	Swift	<i>Chaetura</i> sp.
One	Cayenne Hermit	<i>Phaethornis superciliosus superciliosus</i> (Linné)
Three	Red-vented Hermit	<i>Phaethornis ruber ruber</i> (Linné)
One	Broad-shafted Sabrewing	<i>Campylopterus largipennis</i> (Bodd.)
Two	Black-eared Fairy	<i>Heliothrix aurita aurita</i> (Gmel.)
Six	Black-throated Trogon	<i>Trogonurus curucui curucui</i> (Linné)
Three	Green Trogon	<i>Trogon strigilatus strigilatus</i> (Linné)
Three	Southern Trogon	<i>Chrysotrogon violaceus violaceus</i> (Gmel.)
Two	Black-tailed Trogon	<i>Curucujus melanurus melanurus</i> (Swainson)
Six	Common Ani	<i>Crotophaga ani</i> Linné
Two	Black-spotted Barbet	<i>Capito niger</i> (P. L. S. Mull.)
Five	Sulphur- and White-breasted Toucan	<i>Ramphastos vitellinus</i> Licht.
One	Green Aracari	<i>Pteroglossus viridis</i> (Linné)

Bird census—continued

Two	Golden Jacamar	<i>Jacamerops aurea</i> (P. L. S. Mull.)
One	Collared Puffbird	<i>Bucco capensis</i> Linné
Three	Swallow Puffbird	<i>Chelidoptera tenebrosa tenebrosa</i> (Pall)
One	Spix's Amazonian Woodpecker	<i>Celeus undata</i> (Linné)
One	Red-necked Woodpecker	<i>Scapanus rubricollis</i> (Bodd.)
Two	Lineated Woodpecker	<i>Ceophloeus lineatus lineatus</i> (Linné)
Three	Undulated Piculet	<i>Picumnus buffoni undulatus</i> Hargitt
One	Ashy-backed Bushbird	<i>Dysithamnus mentalis spodi-notus</i> Salv. & God.
Five	Mouse-colored Bushbird	<i>Hypolophus murinus</i> (Scl. & Salv.)
Eight	Cinereous Bushbird	<i>Thamnomanes glaucus</i> Cab.
Three	Pygmy Antbird	<i>Myrmotherula pygmaea</i> (Gmel.)
Five	Rufus-bellied Antbird	<i>Rhopias guttata</i> (Vieill.)
Twelve	White-flanked Antwren	<i>Myrmopagis axillaris axillaris</i> (Vieill.)
One	Gray-breasted Antbird	<i>Myrmopagis cinereiventris cinereiventris</i> (Scl. & Salv.)
Two	Spotted-tailed Antbird	<i>Herpsilochmus sticturus sticturus</i> Salvin
Three	White-bellied Antwren	<i>Rhamphocaenus albiventris albiventris</i> Sclater
Six	White-fronted Antcatcher	<i>Pithys albifrons</i> (Linné)
One	Rufus-fronted Antcatcher	<i>Anoplops rufigula rufigula</i> (Bodd.)
Five	Schomburgk's Antcreeper	<i>Myrmoborus leucophrys angustirostris</i> (Cab.)
One	Woodcock Antbird	<i>Rhopoterpe torquata torquata</i> (Bodd.)
One	Black-faced Ant-thrush	<i>Formicarius colma</i> subsp.
Two	Guiana Spinetail	<i>Synallaxis gujanensis gujanensis</i> (Gmel.)
Five	Dusky-vented Philydor	<i>Philydor erythrocercus erythrocercus</i> (Pelz.)
Two	Brown-tailed Xenops	<i>Xenops genibarbis genibarbis</i> Ill.
Three	Little Wedge-billed Woodhewer	<i>Glyphorhynchus cuneatus</i> subsp.
Two	Guiana Spotted Woodhewer	<i>Xiphorhynchus guttatus sororius</i> (Berl. & Hart.)
One	Chestnut-rumped Woodhewer	<i>Xiphorhynchus pardalotus</i> (Vieill.)
One	Rufus-throated Woodhewer	<i>Dendrexetastes rufigula</i> (Less.)
One	Guiana Curve-billed Woodhewer	<i>Campylorhampus trochilirostris procurvoides</i> (Lafr.)

Bird census—continued

One	British Guiana Flatbill	<i>Crasedoprion olivaceus guianensis</i> McConnell
Two	Pelzeln's Flatbill	<i>Rhynchocyclus sulphureus</i> subsp.
Two	Spotted Tody Flycatcher	<i>Todirostrum maculatum maculatum</i> Desmarest
One	Helmeted Pygmy Tyrant	<i>Colaptes auratus</i> (Bodd.)
Four	Oily Flycatcher	<i>Pipramphus olivaceus olivaceus</i> (Licht.)
Three	Yellow-vented Flycatcher	<i>Elaenia martinica flavogaster</i> (Thun.)
Three	Small-billed Kiskadee	<i>Myiozetetes cayanensis cayanensis</i> (Linné)
Nine	Guiana Kiskadee	<i>Pitangus sulphuratus sulphuratus</i> (Linné)
Four	Lesser Kiskadee	<i>Pitangus lictor lictor</i> (Licht.)
Two	Pitangua Flycatcher	<i>Megarhynchus pitangua</i> (Linné)
Three	Whiskered Flycatcher	<i>Myiobius barbatus barbatus</i> (Gmel.)
One	Royal Great Crest	<i>Onychorhynchus coronatus coronatus</i> (P. L. S. Mull.)
Seven	White-throated Kingbird	<i>Tyrannus melancholicus satrapa</i> (Cab. & Hein.)
Two	Golden-headed Manakin	<i>Pipra erythrocephala erythrocephala</i> (Linné)
Two	White-crowned Black Manakin	<i>Pipra leucocilla leucocilla</i> (Linné)
Three	Crackling Manakin	<i>Manacus manacus manacus</i> (Linné)
Four	Black-tailed Tityra	<i>Tityra cayana</i> (Linné)
Two	Goldbird	<i>Lathria cinerea cinerea</i> (Vieill.)
Five	Spix's Attila	<i>Attila thamnophiloides</i> Spix
Three	Cayenne Chatterer	<i>Cotinga cayana</i> (Linné)
Two	Pompadour Chatterer	<i>Xipholena punicea</i> (Pallas)
Three	Variegated Swallow	<i>Iridoprocne albiventris</i> (Bodd.)
Four	Gray-breasted Martin	<i>Progne chalybea chalybea</i> (Gmel.)
Four	White-banded Swallow	<i>Atticora fasciata</i> (Gmel.)
Three	Guiana House Wren	<i>Troglodytes musculus</i> subsp.
One	Quadrille Bird	<i>Leucolepis musica musica</i> (Bodd.)
Two	Sabian Thrush	<i>Planesticus fumigatus</i> subsp.
Three	Guiana Woodbird	<i>Pachysylvia muscipina muscipina</i> (Scl. & Salv.)
One	Yellow Warbler	<i>Dendroica aestiva aestiva</i> (Gmel.)
Five	Chestnut-bellied Seedeater	<i>Sporophila castaneiventris</i> Cab.
Seven	Olive Kernel-eater	<i>Pitylus canadensis canadensis</i> (Linné)

Bird census—continued

Three	Guiana Bananaquit	<i>Coereba chloropyga guianensis</i> (Cab.)
Four	Turquoise Honey Creeper	<i>Dacnis cayana cayana</i> (Linné)
Eleven	Green Honey Creeper	<i>Chlorophanes spiza spiza</i> (Linné)
One	Violaceous Euphonia	<i>Tanagra violacea violacea</i> (Linné)
Two	Chestnut-headed Tanager	<i>Tangara gyrola</i> (Linné)
Six	Yellow-bellied Tanager	<i>Tangara mexicana mexicana</i> (Linné)
Eight	Blue Tanager	<i>Thraupis episcopus episcopus</i> (Linné)
Two	Eastern Palm Tanager	<i>Thraupis palmarum melanoptera</i> (Sclater)
Eighteen	Silver-beaked Tanager	<i>Ramphocelus carbo carbo</i> (Pall.)
Two	Fulvus-crested Tanager	<i>Tachyphonus surinamus surinamus</i> (Linné)
Two	Golden-crested Tanager	<i>Tachyphonus intercedens</i> Berl.
Fifty	Great Black Cacique	<i>Ostinops decumanus decumanus</i> (Pall.)
One	Yellow-backed Cacique	<i>Cacicus cela</i> (Linné)
Two	Rice-grackle	<i>Cassidix oryzivora oryzivora</i> (Gmel.)
Three	Red-breasted Blackbird	<i>Leistes militaris militaris</i> (Linné)
One	Moriche Oriole	<i>Icterus chryscephalus</i> (Linné)

Out of the total number of Kartabo birds twenty-one are migrants from North America, while the rest are more or less permanent residents, nesting in the district or in adjacent parts of the Colony. While it would seem easy to make this distinction between migrants and residents, as a matter of fact the line is rather loosely drawn. Some, such as the barn swallow, are unmistakably transients, living here in the tropics only during the season of northern cold. But others, such as the yellow warbler, while appearing in unusually large numbers during the season of migration, are also present throughout the year. If such a species should be found breeding it could be defined as migratory only to a limited degree. The egrets, while well known as migrants or as residents in parts of the United States, are resident in British Guiana.

The North American migrants include the following:

Golden Plover	Kingbird
Semipalmated Plover	Bank Swallow
Black-necked Stilt	Barn Swallow

Greater Yellowlegs
 Lesser Yellowlegs
 Solitary Sandpiper
 Spotted Sandpiper
 Upland Plover
 Wilson's Snipe
 Belted Kingfisher
 Yellow-billed Cuckoo

Purple Martin
 Yellow Warbler
 Black-poll Warbler
 Small-billed Water-thrush
 Redstart
 Summer Tanager
 Bobolink

A vivid idea of the relative abundance of species of birds in the tropics as compared with the temperate zones is shown by the avifauna of New York State and that of the quarter of a square mile of jungle about Kartabo. The former, in actual area, is 180,000 times as large as our tropical field of research, and, according to Eaton, contains four hundred and eleven species of birds. For purposes of fair comparison it is necessary to eliminate from this list three exterminated species, six introduced species, and seventy-two accidental visitors which play no real part in the bird life of the State. This leaves three hundred and thirty New York birds as compared with four hundred and sixty-four at Kartabo. These two lists comprise twenty-four orders, of which seventeen are common to both localities, two are found only in New York, and five only at Kartabo.

The relative comparison of the orders is as follows:

The Birds of New York State and of Kartabo

	New York	Kartabo
Total Species.....	330.....	464
Migrants.....	262.....	21

Orders common to both Localities

Galliformes.....	3.....	6
Columbiformes.....	1.....	10
Ralliformes.....	8.....	10
Podicipidiformes.....	5.....	1
Lariformes.....	23.....	4
Charadriiformes.....	38.....	14
Gruiformes.....	1.....	6
Ardeiformes.....	9.....	11
Anseriformes.....	36.....	2
Pelicaniformes.....	4.....	2

Orders common to both localities—continued

Cathartiformes	1	4
Accipitriformes	17	28
Strigiformes	11	4
Coraciiformes	5	50
Cuculiformes	2	11
Piciformes	9	27
Passeriformes	148	241

Orders exclusively or dominantly Temperate

Podicipidiformes	Charadriiformes
Procellariiformes	Anseriformes
Alciformes	Strigiformes
Lariformes	

Orders exclusively or dominantly Tropical

Tinamiformes	Psittaciformes
Columbiformes	Coraciiformes
Gruiformes	Trogoniformes
Phoenicopteriformes	Cuculiformes
Cathartiformes	Scansores
Accipitriformes	Piciformes

Treating the Passeriformes from the point of view of families we find the following interesting line-up between the two localities:

Passeriformes of New York State and of Kartabo

	New York	Kartabo
Total Families	19	23
Total Species	148	241

Families common to both Localities

Tyrannidae	9	48
Hirundinidae	6	8
Muscicapidae	3	1
Troglodytidae	5	7
Mimidae	3	2
Turdidae	8	4
Vireonidae	6	7
Mniotiltidae	38	10
Motacillidae	1	1

Families common to both localities—continued

Fringillidae.....	41.....	17
Tangaridae.....	2.....	22
Icteridae.....	9.....	12
Corvidae.....	5.....	1

Families exclusively or dominantly Temperate

Alaudidae	Sittidae
Bombycillidae	Paridae
Turdidae	Mniotiltidae
Laniidae	Fringillidae
Certhiidae	Corvidae

Families exclusively or dominantly Tropical

Conopophagidae	Dendrocolaptidae
Formicariidae	Tyrannidae
Rhamphocaeidae	Pipridae
Furnariidae	Cotingidae
Synallaxidae	Coerebidae
Xenopidae	Tanagridae

In future monographs, I shall treat in detail the actual annual and semi-annual breeders.

Of the strictly resident birds, an astonishingly large number are extremely local or sedentary. For example, if I wish to hear quadrille wrens, or at least see them, I am almost certain of doing so every month in the year by going to the Hacka Palm Swamp, in the vicinity of R11; from January to December the tiny chuckle-dee flycatcherlets, *Colopteryx galeatus macconnelli*, inhabit N12; crackling manakins, *Manacus manacus manacus*, never fail me in P15; and Guiana wrens, *Thryothorus griseigula*, are ever present tenants of the region about D8.

The nesting is in many cases almost as exact, and an egg of the Who-are-you, *Nyctidromus albicollis*, is unfailing, twice a year, in J12.

Except during the breeding season, one is impressed by the social instinct of the bird life, many species keeping in pure culture flocks, such as parrakeets, caciques and toucans, or in the never-failing, peripatetic, mixed flocks of ant-birds, tree-creepers and other small fry.

The point of view I have chosen to take up here in special detail

is the interrelationship of enemy and prey, concerning the two more primitive of the trio of animal activities.

The problem of avian enemies is an example of how even years of intensive concentration in the tropics result in only a skimming of the surface. One of the most evident facts is that birds have terrific competition to contend with. Again and again I have lost eggs or young by delaying a day, or even an hour or two, in collecting them. On the second visit they will be found broken or gone altogether, and yet in my examination of hundreds of stomachs of all classes of vertebrates I have found only ten species feeding on birds, one of which had devoured the eggs alone. Five of these were snakes, four hawks and one was a mammal. Even this list should rightly be cut down to six, as three of the snakes were feeding on our domestic chickens,—although this is very certain evidence of ornithopagous habits. Unquestionably I have missed many enemies.

My evidence as to the diet of birds is more positive, as the following list shows:

CLASSIFIED FOOD OF BIRDS

Springtails	<i>Chloronherpes flavigula</i>
Earth-worms	<i>Aramides cajanea</i>
Mollusks	<i>Creciscus viridis</i> <i>Hylopezus macularia</i> <i>Synallaxis guianensis</i> <i>Myiarchus ferox</i>
Sowbugs	<i>Tachyphonus rufus</i>
Small Crustaceans	<i>Theristicus caudatus</i> (several hundred)
Shrimps	<i>Butorides striata</i> <i>Cochlearius cochlearius</i> <i>Actitis macularia</i> <i>Pitangus sulphureus</i>
Crabs	<i>Butorides striata</i> <i>Actitis macularia</i> <i>Theristicus caudatus</i> <i>Tigrisoma lineatum</i> <i>Sclateria naevia</i> <i>Pitangus sulphureus</i> <i>Aramides cajanea</i> <i>Heliornis fulica</i> <i>Cochlearius cochlearius</i>

Classified food of birds—continued

Scorpions	<i>Dromococcyx pavoninus</i> <i>Pithys albifrons</i> <i>Campylorhamphus procurvoides</i>
Millipedes	<i>Crotophaga ani</i> <i>Erionotis amazonicus</i> <i>Formicarius moniliger crissalis</i> <i>Xiphorhynchus pardalotus</i> <i>Dendrocolaptes certhia</i>
Centipedes	<i>Leucopternis melanops</i> <i>Crotophaga ani</i> <i>Erionotis amazonicus</i> <i>Formicarius colma</i> <i>Hylopezus macularia</i> <i>Cyanocorax cayana</i>
Harvestmen	<i>Crotophaga ani</i> <i>Scateria naevia</i>
Spiders	Sixty species of birds
Mites	Two species of birds
Orthoptera (total)	Seventy-eight species of birds
Grasshoppers	Forty-six species of birds
Roaches	Twenty-seven species of birds
Crickets	Five species of birds
Rhipipteryx	<i>Myrmoborus angustirostris</i>
Mole Crickets	<i>Butorides striata</i> <i>Crotophaga major</i>
Mantids	Eight species of birds
Neuroptera (total)	Five species of birds
Mantispid	<i>Dendrocincla fuliginosa</i>
Diptera	Twenty-one species of birds
Termites	<i>Ibycter americanus</i> <i>Chloronerpes flavigula</i> <i>Celeus hellmayri</i> <i>Picumnus buffoni undulatus</i> <i>Myrmopagis axillaris</i> <i>Myrmoderas ferruginea</i> <i>Hypocnemis cantator</i> <i>Myrmoborus angustirostris</i>

Classified food of birds—continued

	<i>Formicarius colma</i>
	<i>Hylopezus macularia</i>
	<i>Glyphorhynchus cuneatus</i>
	<i>Placostomus gumia</i>
	<i>Pipromorpha oleaginea</i>
	<i>Muscivora tyrannus</i>
	<i>Atticora fasciata</i>
	<i>Elaenea cristata whitelyi</i>
Hemiptera (total)	Forty-one species of birds
Cicadas	Ten species of birds
Reduviid	One species
Dragonflies	<i>Pitangus lictor</i> <i>Tachycineta albiventris</i> <i>Progne chalybea</i>
Damselfly	<i>Notharcus tectus</i>
Lepidoptera (total)	Thirty-six species (no butterflies)
Moths	<i>Falco ruficularis</i> <i>Lurocalis semitorquatus</i> <i>Jacamerops aurea</i> <i>Thamnophilus incertus</i> <i>Myiodynastes maculatus</i> <i>Progne chalybea</i> <i>Scotothorus olivaceus</i>
Lepidopterous Pupae	<i>Corythopsis torquata anthoides</i>
Butterfly Eggs	<i>Myrmoderus ferruginea</i>
Caterpillars	Twenty-nine species of birds
Beetles	One hundred and forty species of birds
Cetonids and Metallic Beetles	Twenty-two species
Weevils	Forty-two species
Water Beetles	<i>Butorides striata</i>
Hymenoptera (total)	Ninety-five species of birds
Hymenoptera (general)	Twenty-three species
Wasps	Twelve species of birds
Bees	Eight species of birds
Ants	Fifty-eight species of birds

Classified food of birds—continued

Leaf-Cutting Ants (<i>Atta</i>)	<i>Myiarchus ferox</i>
Fish	<i>Ardea cocoi</i> <i>Phaetusa chloropoda</i> <i>Sterna superciliosa</i> <i>Cochlearius cochlearius</i> <i>Pitangus sulphureus</i> <i>Phalacrocorax nigrea</i> <i>Anhinga anhinga</i> <i>Chloroceryle inda</i>
<i>Bufo marinus</i>	<i>Urubitinga urubitinga</i>
<i>Bufo guttatus</i>	<i>Urubitinga urubitinga</i>
Unidentified Lizards	<i>Micrastur interstes</i> <i>Attila spadiceus spodiostethus</i> <i>Attila thamnophiloides</i> <i>Attila uropygialis</i>
<i>Anolis</i>	<i>Harpagus bidentatus</i>
<i>Cnemidophorus</i>	<i>Leucopternis melanops</i> <i>Hylopezus macularia</i>
<i>Ameiva</i>	<i>Leucopternis melanops</i> <i>Gampsonyx swainsoni</i>
<i>Polychrus</i>	<i>Elanoides furcatus</i>
Snake	<i>Pulsatrix perspicillata</i>
Rail	<i>Harpia harpyia</i>
Tanager (nestling)	<i>Elanoides forficatus yetupa</i>
<i>Tangara violacea</i>	<i>Falco rufigularis</i>
<i>Chlorophanes spiza</i>	<i>Falco albigularis</i>
<i>Cyanerpes cyaneus</i>	<i>Elanoides forficatus yetupa</i> (egg only) <i>Falco albigularis</i>
Unidentified Birds	<i>Asturina nitida</i> <i>Falco rufigularis</i>
Mouse	<i>Rupornis magnirostris</i> <i>Chondrohierax palliatus</i> <i>Ciccaba supercilialis macconnelli</i>
Bat	<i>Ciccaba huhula</i>
Monkey	<i>Thrasaetus harpyia</i> <i>Spizaetus tyrannus</i>
Three-toed Sloth	<i>Harpia harpyia</i>

In the quarter square mile of jungle under observation I have breeding records of two hundred and five species of birds, scattered throughout seven hundred and three separate records of eggs, young or breeding condition.

To the following list of the species I have added the months in each case and the number of times in which breeding has been observed in each month. I have followed Chubb in his "Birds of British Guiana" as to sequence and scientific names:

BREEDING RECORD OF KARTABO BIRDS

Tinamus major—March (7), April (17), May (7).

Crypturus soui—May (2).

Crypturus variegatus—March (3), April (5), May (3), June (4), July (3), September, October.

Crax nigra—March, April (3), August.

Penelope marail—July.

Penelope granti—March, April (2).

Ortalis motmot—May, August.

Odontophorus guianensis—April (2), May (3), June (2), August (2), September.

Columba speciosa—April (4), May.

Columba purpureotincta—May.

Chaemepelia griseola—August.

Chaemepelia talpacoti—March (3), April, September (3), November, December.

Leptoptila rufaxilla—March (2), April (5), May (5), September.

Leptoptila verreauxi—September.

Oreopelia montana—March, April (5), May (5), June (3).

Aramides cajanea cajanea—June.

Porzana albicollis—April to mid-July, fresh eggs.

Creciscus exilis—April, September.

Creciscus viridis—April 5–July 13, fresh eggs; June.

Phaethusa chloropoda—August, 3 month juv.

Jacana spinosa—January, June.

Eurypyga helias—April, May, June (2).

Psophia crepitans—March, April, August.

Theristicus caudatus—June.

Butorides striata—August.

Anhinga anhinga—June.

Ibycter ater—March.

Milvago chimachima—March, May.

Micrastur gilvicollis—April.

Leucopternis melanops—March.

Elanoides forficatus—March.

Chondrohierax palliatus—May.

Breeding record of birds—continued

- Ictinia plumbea*—March, April, August.
Ciccaba superciliaris—April.
Amazona dufresniana—March.
Pionus menstruus—June.
Pionus fuscus—March.
Pionites melanocephala—June.
Chloroceryle amazona—July.
Chloroceryle inda—May.
Chloroceryle a. aenea—July.
Momotus m. momota—April (2), May.
Nyctibius griseus—April, September (2).
Hydropsalis schomburghki—May.
Nyctidromus albicollis—March, April (3), May, August, September (4).
Caprimulgus nigrescens—March (2), April (5), May, June, July (2), September (4).
Chaetura brachyura—March.
Cypseloides fumigatus—June.
Phaethornis superciliosus—May, August, September, November.
Phaethornis ruber—March (2), September, October.
Campylopterus largipennis—May, September.
Thalurania furcata fissilis—March, April, May (2), July (2).
Anthrocothorax violicauda—May (3), July, August.
Polytmus chrysobranchus—May (2).
Topaza pella—March, April, May, July (4), August (3), September.
Heliothrix aurita—July.
Trogonurus collaris—April, May (2).
Trogon melanurus—May.
Trogon rufus—April.
Trogon s. strigilatus—March, April, June.
Trogon violaceus—May.
Piaya cayana—April, July, August, September.
Neomorphus rufipennis—June.
Dromococcyx pavoninus—May, June.
Crotophaga ani—February (2), March, April (2), June, September (3).
Capito niger—April.
Ramphastus monilis—March.
Ramphastus vitellinus—March, April, May.
Pteroglossus aracari—April (2), August.
Pteroglossus viridis—March.
Urogalba d. dea—September.
Galbula albirostris—May, August, September.
Bucco capensis—April, August.
Bucco macrorhynchus—May.
Monasa niger—July (2).
Chelidoptera tenebrosa—April (2), September.
Melanerpes rubrifrons—March, April.
Campephilus rubicollis—March, July.

Breeding record of birds—continued

Campephilus melanoleucus—March.

Picumnus undulatus—May.

Corythopsis torquata anthoides—April, May (2), June.

Cymbilaimus lineatus—May, July.

Frederickena viridis—September.

Erionotis tristis—May.

Dysithamnus murinus—March (2), April, May (2), June, October.

Dysithamnus saturninus—April.

Thamnomanes glaucus—March (2), May.

Myrmopagis axillaris—April (3), June.

Poliolaema cinereiventris—April, June.

Poliolaema guttata—May, September.

Herpsilochmus sticturus—May.

Terenura spodioptila—May, June, August.

Rhamphocaenus albiventris—March, April, May, August, September (3).

Cercomacra tyrannina saturator—November.

Manikup albifrons—March, April (2), May (2), June, September.

Anoplops rufigula—June, August.

Myrmornis torquata—August.

Sclateria naevia—June.

Sclateria leucostigma—May.

Myrmoderas ferrugineus—January, June.

Hypocnemis cantator—May, April, September.

Myrmoborus angustirostris—May, June.

Dichropogon poecilonota—July.

Stictomyrmornis naevius—March.

Formicarius colma—April, June.

Formicarius crissalis—May.

Grallaria brevicauda—April.

Hylopezus macularia macconnelli—April, May, June (4), July (3).

Sclerurus caudacutus—May.

Synallaxis guianensis—February, March, May, June, July (2).

Synallaxis cinnamomea—February, March.

Automolus turdinus macconnelli—March (2), June, August.

Automolus cervicalis—March, May.

Glyphorhynchus cuneatus simillimus—June (4), July (3), August, October, November (2).

Dendrocincla fuliginosa—April.

Xiphorhynchus sororius—March.

Campylorhampus procurvoides—March.

Dendrocolaptes plagosus—March, April, May.

Fluvicola pica—February, June.

Arundinicola leucocephala—April.

Placostomus griseiceps—May.

Placostomus saturatus—June, August.

Breeding record of birds—continued

- Rhynchocylus sulphureus* *examinatus*—May, June.
Rhynchocylus poliocephalus inquistor—September.
Todirostrum cinereum—February (3), May, June.
Todirostrum maculatum—March, June, September.
Perisotriccus ecaudatus miserabilis—May, September.
Colopteryx galeatus macconnelli—May (2).
Pipromorpha oleaginea macconnelli—March (2), April (3), May.
Ornithion pusillum—March (2).
Tyranniscus acer—April.
Elaeena pagana macconnelli—May, June, September.
Elainopsis guianensis—May, July.
Legatus albicollis—March, May.
Myiozetetes cayennensis—February, March, April, May, July.
Pitangus sulphuratus—January, February (2), March (3), April, May.
Pitangus lictor—February (2), March (2), May (2), September.
Megarhynchus pitangua—March.
Myiobius barbatus—March, May (3), June, July (2), October.
Myiarchus ferox—February.
Empidonomus varius parvirostris—May.
Tyrannus satrapa—March (4), April (5), May (4), September (2).
Muscivora tyrannus—March.
Pipra aureola—March.
Pipra erythrocephala—February, March, April, June.
Pipra leucocilla—March (2), May (3), July, December.
Pipra suavis—March, April, May.
Piprites chlorion—May.
Corapipo gutturalis—March, May.
Chiromachea manacus—March (3), July.
Scotothorus olivaceus—December.
Tityra cayana—March (2).
Lathria cinerea—March (2).
Laniocera hypophryra—May.
Lipangus simplex—September.
Attila spadiceus spodiostethus—March, May.
Phoenicocercus carnifex—January.
Cotinga cayana—September.
Xipholena punicea—March, June.
Querula purpurata—April (2).
Calvifrons calvus—June, September.
Tachycineta albiventris—April, September.
Progne chalybea—March (3), May (3), June, September.
Pheugopedius griseigula—May, June (2), October.
Troglodytes clarus—February, May.
Leucolepis arada—April, June (2), July.
Microcerculus bambla—May.
Planesticus fredericki—May (2), June.

*Breeding record of birds—continued**Planesticus albiventer*—April.*Planesticus phaeopygus*—April (2), May (4), June.*Pachysylvia muscicapina*—November.*Cyanocompsa rothschildi*—January.*Oryzoborus brevirostris*—March (2), June.*Sporophila bouvronides*—May.*Sporophila lineola*—April, June.*Sporophila gutturalis roraimae*—March, May, June.*Microphila castaneiventris*—March (4), April, June, July, September, November.*Microphila minuta*—May.*Volatinia splendens*—July.*Pitylus grossus*—July.*Caryothraustes canadensis*—March, November.*Coccopsis gularis*—April, June, October.*Arremon taciturnus*—March, April (2), May (4), June.*Coereba guianensis*—March, September (2).*Dacnis cayana*—September.*Cyanerpes cyaneus*—May (2), June (3), July (2).*Cyanerpes caeruleus*—May (2).*Tanagra cayennensis*—June.*Tanagra violacea*—March, April, May, September.*Tanagrella velia*—December.*Tangara gyrola*—June, August.*Tangara mexicana*—April, May, September, December.*Thraupis episcopus*—March (3), April (2), May (2), June, September, October.*Thraupis melanoptera*—February, April (4), May (2).*Ramphocoelus carbo*—March (5), April (4), May (5), August, October.*Lanio fulvus*—April, May, June (2).*Tachyphonus rufus*—March (3), April (2), May (2).*Ostinops decumanus*—April (2).*Cacicus cela*—March (3), April, September.*Cassidix oryzivora*—March (3), April (2).*Leistes militaris*—April, May, June, September, October.*Icterus xanthornus*—February, June.*Melanopsar chrysocephalus*—February (2), March (2), July.*Cyanocorax cayanus*—March, April, May (3), June.

We thus have the following interesting distribution of breeding records through the twelve months; beginning with February as that is the first month of the Short Dry Season:

February	20	May	154
March	127	June	84
April	142	July	49

August	30	November	8
September	59	December	6
October	10	January	4

As shown in the accompanying chart, the climax of the breeding season is suddenly approximated in March, reaching its extreme in May, then descending rather abruptly and evenly to a low mark in August. September shows a second node of activity, indicating the second nesting season for a number of species which have already bred in March. The descent from September is abrupt and an exceedingly low mark at once reached, which descends even lower in the following three months, becoming almost nil in January.

THE ORDERS OF KARTABO BIRDS

Twenty-two orders of birds are represented in the research area, leaving three Guiana orders absent; these latter being hoatzins, petrels and horned screamers.

The following is a list of the orders, with the numbers of their respective species:

Order TINAMIFORMES

Family TINAMIDAE

Four species of these solitary birds are recorded, two common, one rare and one unique. All are medium-sized, brownish birds, feeding, nesting, and, with one exception, roosting on the jungle floor. A *Tinamus* and a *Crypturus* are among our chief sources of food, and I have records of one hundred and seventy-six shot either by ourselves or our Indian hunters. These were taken in or just outside of the Kartabo area, and yet the birds are as plentiful as they ever were. The remarkable life-history and breeding habits of the birds I am making the subject of a monograph which will follow this ecological paper. The birds are very protectively colored, as are the single eggs of *Crypturus*, but those of *Tinamus* contrast strongly with the dead leaves. The voice of *Tinamus* is a loud, penetrating, sweet whistle, a very characteristic jungle sound in the evening and on moonlit nights.

Order GALLIFORMES

Family CRACIDAE

Four species of jungle "turkeys" live within the quarter mile, none of them really common nor yet rare. Although pheasant-like

in superficial appearance, they are quite arboreal. The *Crax* and the two *Penelopes* are often shot for food. *Ortalis motmot* is wholly unlike all the other Galliformes in frequenting the haunts of man, coming close to the edge of our clearing at daybreak and calling in loud duets for many minutes. Flocks of the *Penelopes* in the jungle give utterance in the early morning to the most astonishing outcry of any creature I have ever heard. We have shot about sixty each of *Crax* and *Penelope* without diminishing their numbers.

Family ODONTOPHORIDAE

Two small leaf-colored partridges live on the jungle floor, one rarely seen, the other occasionally. They lay four white eggs, associate in small flocks, the voice is not loud, and their food consists chiefly of roaches and beetles. The Indians have brought in about twenty-five.

Order COLUMBIFORMES

Family COLUMBIDAE

Ten doves and pigeons range in size from the big *Lepidoenas speciosa* to the tiny ground doves *Chamaepelia*. The latter are found only in the clearings, and are very rare at Kartabo, not having yet established themselves. The larger jungle doves are solitary, with loud, booming voices heard as often at mid-day as in late afternoon. Many of them nest low down, from two to six feet from the ground.

Order RALLIFORMES

Family RALLIDAE

Nine species include such a diversity of forms as *Aramides*, *Porzana*, *Creciscus* and *Ionornis*. Only two *Creciscus* are other than rare, nesting in the coarse grass of clearings. Beetles, ants, small mollusks, earth-worms and crabs form their food.

Family HELIORNITHIDAE

The strange fin-foot, *Heliornis*, is occasionally seen and taken in the jungle creeks and among the mangroves. I have never found anything but spiders and crabs in its stomach. In general appearance and haunts this takes the place of grebes, which are exceedingly rare at Kartabo.

Order PODICIPIDIFORMES

Family PODICIPIDAE

Twice I have seen pied-billed grebes near the mouths of jungle creeks.

Order LARIFORMES

Family LARIDAE

Three terns and a skimmer comprise this family, *Phaetusa* being common, the others rare. I have seen two species of terns, besides feeding on fish, sharing a flight of termites with swifts, martins and flycatchers.

Order CHARADRIIFORMES

Family CHARADRIIDAE

The wading birds include four plovers, a curlew, a stilt, two yellow-shanks, two sandpipers, and three snipe, nine of which are migrants. The commonest of these is *Actitis*, healthy individuals of which are found every month in the year.

Family JACANIDAE

The jacana is very rare at Kartabo, this, together with ground doves and red-breasted starlings, being occasional strays from the Penal Settlement, three miles down river.

Order GRUIFORMES

Family ARAMIDAE

The limpkin is a rare bird at Kartabo, being much more common on the coast.

Family EURYPYGIDAE

The sun bittern is occasional, and rarely nests among the mangroves, depositing its single large egg on a depression on some horizontal limb. Only during its courtship is it other than a silent, inconspicuous bird. Like *Psophia*, it makes an ideal pet, quickly becoming tame and remaining close to the house.

Family PSOPHIDAE

The long-legged, hump-backed trumpeter, strange as to appearance and actions, and of unknown breeding habits, is almost common, being found in good-sized flocks in the jungle, and at the

first alarm flying well up into the high trees. Its strange, ventriloquial voice is only occasionally heard, and its food consists almost wholly of beetles and ants. We have had over fifty brought in for the table, and are seldom without a tame "Warracabra" walking about the compound.



Fig. 14. Young trumpeter, *Psophia crepitans* Linné.
Photograph by Paul G. Howes.

Family IBIDIDAE

Two ibises occur, one, *Theristicus*, a very rare straggler from the inland savannas, and *Harpiprion*, a fairly common feeder along shore. Their food is tiny crustaceans, crabs and worms.

Family CICONIIDAE

A March record of four wood ibises, *Mycteria*, flying slowly over the laboratory is the only occurrence of these birds.

Order ARDEIFORMES

Family ARDEIDAE

Eleven herons have been seen, some, as *Ardea cocoi*, *Cochlearius* and *Tigrisoma* not rare, others as the egret, *Casmerodius*, appearing only as a few stray young birds after the breeding season. Crabs and shrimps form much more of their food than fish, although I have found two puffers, *Colomesus*, in the stomach of a cocoi heron.

Order PHOENICOPTERIFORMES

Family PHOENICOPTERIDAE

Three flamingoes flying low overhead is the only record for Kartabo.

Order ANSERIFORMES

Family ANATIDAE

Kartabo is both too low down-river and too far above the coast to have many ducks. The splendid Muscovy duck, *Cairina*, is rarely observed, and *Dendrocygna* now and then perch among the mangroves.

Order PELICANIFORMES

Family PHALACROCORACIDAE

The little river cormorants are occasional, appearing now and then, perching on rocks out in the river and feeding on the armored catfish which crawl out over the mud-flats.

Family ANHINGIDAE

The identical words apply to the cosmopolitan snakebird, except that its food consists solely of small fish.

Order CATHARTIFORMES

Family CATHARTIDAE

Four vultures visit Kartabo. The black *Coragyps*, which is the most abundant on the coast, is unique here, a single individual having been seen. Offal will at once attract many yellow-headed vultures, and more rarely a red-head or a white king vulture.

Order ACCIPITRIFORMES

Family FALCONIDAE

Twenty-eight hawks and eagles form a splendid section of the Kartabo avifauna. *Leucopternis*, *Ictinia* and *Elanoides* are the commonest forms, but occur only in pairs or in families of three. A number do their hunting beneath the roof of the jungle, and often can be flushed from their prey on the ground.

Ibycter is a degenerate falcon which has taken to a vegetable diet and to utterances which outdo the macaws. The giants *Morphnus*, *Spizaetus* and *Thrasaëtus* are so rare that their occurrence is an event. All examined have been feeding on monkeys.

Except for the above-mentioned *Ibycter* and the low-soaring *Elanoides*, accipiters are not conspicuous and are never gregarious.

One more exception is *Pandion*. A fish-hawk is usually to be seen perched on a beacon off-shore, and often catches fish close to our stelling.

Order STRIGIFORMES

Family STRIGIDAE

Four owls occur, of which *Pulsatrix*, the spectacled, is far most often seen or heard. It kills snakes and birds, while *Ciccaba* prefers mice. The voice of any owl is a rare sound in the tropical jungle.

Order PSITTACIFORMES

Family PSITTACIDAE

- The macaws, parrots and parrakeets number seventeen, of which six or eight are fairly common. *Ara* in pairs, *Amazona* in small, and *Touit* in large flocks, and all with loud discordant cries, are characteristic features of every-day life in the jungle. No matter how brilliant their coloring, the birds vanish when perching quietly among the lights and shadows of the foliage. All the nests found have been in hollow trees. Every one without exception is a vegetarian.

Order CORACIIFORMES

This hodge-podge comprises five diverse families,—kingfishers, motmots, goatsuckers, swifts and hummingbirds.

Family ALCEDINIDAE

Five autochthonous kingfishers and one migrant are found at Kartabo. Two specimens of our northern belted kingfisher have been secured, apparently southern stragglers. The other native species are about equally common, the larger *Megaceryle* haunting the open river, and the tiny *Chloroceryle* usually preferring the jungle creeks. All nest in the clay banks. Their notes are frequently heard and are proportionate to their size,—the big kingfisher springing a terrific rattle, and the small one uttering a sharp, high clicking.

Family MOMOTIDAE

The Guiana motmot sits in pairs in the jungle, attracting the ear by its basso-profundo notes, and the eye by its pendulum-jerking tail. It is almost common, but local, and feeds almost exclusively on coleoptera.

Family CAPRIMULGIDAE

Nine goatsuckers are found at Kartabo, three abundant vocally, and two in actual numbers. *Nyctidromus albicollis* and *Caprimulgus nigrescens* call about the laboratory every evening and morning throughout their bi-annual breeding seasons. From deep in the jungle there is heard the weird call of *Nyctibius*, the poor-me-one. This giant species is usually found up the creeks, where it deposits its egg on the top of rotten stumps. The two former lay their single egg in the bushy clearings near the laboratory at intervals of six months. Beetles and small moths form the principal food of goatsuckers hereabouts.

Family MICROPODIDAE

Eight swifts have been shot soaring over Kartabo, the commonest *Chaetura spinicauda*. The palm swift, *Reinarda*, and the feather-toed swift *Panyptila*, are decidedly rare, but occur every year, feeding high or low, according to the elevation of volant insect life.

Family TROCHILIDAE

Twenty-six hummingbirds have been taken out of the forty recorded from Guiana. Probably at least a dozen more remain

to be detected. Ten species are common, and the nests of five of them may be counted on along the vegetation of the river banks. I have obtained scores from one flowering tree, and individuals often have a very regular route, visiting the same spike of flowers or bushy inflorescence morning after morning at the same minute. Their courtship is exceedingly elaborate, and their voices, when raised in anger between battling males, are astonishingly loud.

Order TROGONES

Family TROGONIDAE

Five species of beautiful trogons occur, one of which is unique, and two others common. Their notes are loud and monotonous, they lay their eggs in termite nests, and are tame, stupid, very wonderfully colored birds. Beetles are easily first in their regimen, but they also take spiders, caterpillars, ants, grasshoppers, and cicadas in numbers.

Order CUCULIFORMES

Family CUCULIDAE

Eleven interesting birds form this assemblage, including the big rufous cuckoo, *Piaya*, the road-runner-like *Neomorphus*, the sedentary wife-sick, *Tapera*, and the two inimitable anis or old witch birds, *Crotophaga*. The latter are by far the most common, but all are far from rare. Much remains to be worked out in regard to the nesting habits of these cuckoos. *Tapera* and *Crotophaga* are inhabitants of clearings, while the rest are more jungle birds. The voices of these two are the only ones which are insistent enough to produce a deep impression on the memory. Insects of every conceivable group are eaten, but *Crotophaga* specializes in harvestmen, centipedes, squash bugs, millipedes, scorpions and other seemingly unpleasant items.

Order SCANSORES

Family CAPITONIDAE

One barbet represents its family, a brightly variegated bird, rather common in mid-jungle, often found with flocks of antbirds and warblers. Small berries form its food.

Family RAMPHASTIDAE

Five toucans live in the research area, three of which I have found breeding. Two are rare, three common. They haunt the tree-tops, and are often found in large flocks except during the breeding season. *Ramphastus vitellinus* is abundant, and their yelping voices are among the commonest of jungle sounds, and carry a mile or more.

Order PICIFORMES

Family GALBULIDAE

Five gorgeously colored jacamars live in the deep jungle, silently fly-catching from favorite perches. *Psilopornis albirostris*, the commonest species, breeds in termite nests.

Family BUCCONIDAE

Of this varied and interesting tropical family there are seven species at Kartabo. Three are fairly common, all jungle birds except *Chelidoptera*, which haunts clearings. The nests are made in stubs (*Bucco*), in holes in the jungle floor (*Monasa*), or in open, sandy soil (*Chelidoptera*). As a rule they are solitary, or found in pairs, usually silent, but with possibilities of extraordinarily varied notes.

Family PICIDAE

Fourteen woodpeckers hammer the trees in the research area, the great *Campephilus* sending a basso-profundo roll for a mile through the jungle, while the tiny *Picumnus* taps almost inaudibly. Several are constantly associated with flocks of antbirds and wood-hewers, two or three are found exclusively in and about the dead trees bordering old Indian clearings. They are all solitary, keep well up and in deep jungle are almost tree-top birds. As elsewhere, their voices are unmistakable, loud and penetrating.

Order PASSERIFORMES

This great group includes twenty-three families and two hundred and forty species, more than fifty percent of the whole Kartabo avifauna. They may be divided roughly into two divisions, first, twelve families, two of which are typically tropical, and the other ten absolutely so, and a second division of eleven families, most of which are as well or better developed in the temperate regions. In the first division there are one hundred and sixty-eight species, in

the second sixty-five. If we except Coerebidae and Tanagridae, the two divisions are aligned systematically as well as geographically—the remaining ten tropical families being also the first ten in a linear succession of Passeriform families.

There are ten species of migrants from the United States. All the remainder are residents within or at least just without the research area.

Family CONOPOPHAGIDAE

A single species, *Corythopsis*, represents this small family in the quarter square mile of research area. It is found in deep jungle, where it *walks* about on the leaves, and nests rather commonly in the same situation. It feeds on beetles, spiders and caterpillars. It is a solitary bird and a silent one. Its coloring, like that of *Arremon taciturnus*, is that of a bird only recently adapted to life in the dimness of primitive jungles.

Family FORMICARIIDAE

Thirty-nine species of antbirds occur at Kartabo, out of the fifty-one which have been recorded from British Guiana. They are by far the commonest birds of the jungle and one can seldom walk more than a few yards before hearing some one of their characteristic call-notes.

All are strong, sturdy birds of more or less sombre coloring and in their variety of general structure and activity they show very remarkable radial adaptation, paralleling many diverse groups of temperate woods, such as flycatchers, shrikes, vireos, warblers, wrens, titmice, nuthatches and thrushes, while some genera strikingly resemble such oriental forms as pittas.

When not nesting on the ground or in low bushes, they are often found in flocks with other birds of their family as well as woodpeckers, woodhewers, tanagers and others. These flocks move slowly through the jungle, each species feeding in its particular manner. The name antbird is derived from a favorite habit of many of attending the battle-front fan of army ants, benefiting by the hosts of insects which rise in vain attempts to escape. *Manikup albifrons* is the antbird *par excellence*, and its loud chirp is almost always an indication of the exact location of one of the army ants' fans of activity.

Family RHAMPHOCAENIDAE

The syrinx of this long-tailed, gnat-catcher-like antbird *Rhamphocaenus*, first led me to suspect its isolated character and when once my attention was focussed, I soon realized that it was out of place in *Formicariidae*. Mr. de W. Miller independently came to the same conclusion. It flocks with the smaller antbirds and is far from rare, being as tame as are most unusually small, delicate birds.

Family FURNARIIDAE

Two of the strange oven-birds, *Sclerurus*, live at Kartabo, one not uncommon and occasionally breeding.

Family SYNALLAXIDAE

One of the most interesting families of Kartabo birds. In habits they are as diverse as cuckoos, and in structure very remarkable readaptations for a normal perching life, while some of them still retain the stiffened rectrices, and all are still garbed in the pattern and colors, of their woodhewer-like ancestor.

Two species of *Synallaxis* haunt the clearing, build huge nests of sticks and thorns, and call to one another with loud, varied notes. Their stiffened tails are used only in a wren-like fashion. Two *Automolus* and a *Philydor* live in the deep jungle, nesting in tunnels bored in earthen banks,—silent, furtive birds.

Family XENOPIDAE

The single species of *Xenops* composing this family is another aberrant woodhewer, specializing in the direction of nuthatches. It never uses its tail as a prop, but creeps about twigs and branches. The resemblance is also striking both in regard to the shape of the beak and the general pattern of the plumage. It is a common bird, and is usually found in the flocks of antbirds.

Family DENDROCOLAPTIDAE

These thirteen sturdy birds fill the place of woodpeckers in the mid-jungle. All nest in hollows, either in the tops of stumps, in narrow folds of tree buttresses, or in termite nests. They flock with other birds, the smaller with antbirds and the larger with jays and toucans. *Glyphorhynchus* is abundant and eight other species common. Their voices are loud and one of the most memorably characteristic jungle sounds, either loud, startling and woodpecker-like, or sweet, dropping cadenzas.

All climb up tree-trunks, using their stiffened rectrices, and all have a general similarity of livery,—rufous red backs, wings and tails, and pale striped heads, necks and underparts.

Although uniform in general activities, and method of progression, yet the diversity in the actual procuring of food is reflected in the remarkable variety of beaks, some short and wedge-shaped, others resembling awls, forceps, needles, and, as an extreme, very long, slender, sickle beaks, curving far round, recalling the female huia bird of New Zealand, or certain hummingbirds.

Family TYRANNIDAE

The dominant family of Passeriformes in Guiana, and, at least in number of species, at Kartabo. In the research area, forty-eight occur, compared with sixty-nine in the whole Colony. We may make a very rough division of the thirty-five genera into a smaller number which inhabit the clearings and open spaces, typified by *Fluvicola*, *Pitangus*, *Tyrannus*, and *Muscivora*, a still smaller group which haunt the tree-tops, glades, or at least keep to sunny places, such as the marvellous *Onychorhynchus coronatus*. All of these and the others of these two groups have touches or patches of brilliant color, but the majority of deep jungle Tyrannidae, like our wood pewees, are clad in sombre greens and browns. Among many of these are *Myobius*, and the many flat-bills and midget flycatchers.

As the food list shows, many flycatchers are almost wholly vegetarians, while some are experimenting in new organic fields, such as the kiskadee, *Pitangus*, which has developed very general piscivorous habits.

The voice of these birds is, as a rule, loud and persistent, with strong carrying power. Those of the clearings have a much greater assortment of tones than the jungle species.

Family PIPRIDAE

Eleven of these little jungle birds live here. The females are sombre green and sit on their two eggs in tiny cup nests only a few feet from the ground. Their mates in varied liveries of black, white, orange, and even mother-of-pearl, fly about the mid-jungle and utter strange calls, some even cracking their wing feathers. Five are common, most of the others occasional.

Family COTINGIDAE

Twenty spectacular species are found in the Kartabo jungle, each remarkable for voice or color or habit. *Tityra* and *Attila* are clearing birds nesting in hollow trees. The latter is the brain-fever bird of this region, its never-ending call of three or five notes persisting through the heat for many hours on end. *Lathria* inhabits the deepest swamps, where it whips out tones which carry over a mile. The calf-like call of *Calvifrons*, the gorgeous coloring of *Xipholena* and *Cotinga*, culminate in the pure white plumage, the fleshy tentacles and the marvellous notes of *Vavasouria*, the bellbird.

Almost all live in families, in the tops of the tallest trees, are probably more common than I ever know, and yield their nesting secrets only to the most persistent searching. One exception to this last was a female *Xipholena* who nested in a bamboo overhanging the laboratory.

Family HIRUNDINIDAE

Swallows are abundant along the rivers but almost never enter the deep jungle. Eight species occur, two of which are migrants. The Guiana martin, *Progne chalybea*, and the variegated swallow, *Iridoprocne*, are abundant, and ready to use any box which is put up on a pole over the water. *Atticora* is one of the most beautiful, common on jungle creeks, nesting in holes in the banks.

Family MUSCICAPIDAE

A single, rare gnat-catcher represents this family.

Family TROGLODYTIDAE

Seven wrens live in these tropics, one a species of Troglodytes, as friendly to man as elsewhere, the others living in deep jungle. All are characteristic as to tails, actions and bubbling music, while the quadrille bird, *Leucolepis*, is one of the most wonderful songsters of the jungle,—singing an ever-varied flute-like theme which is among the sweetest of all bird voices. Decidedly family birds, found in pairs, threes or fours.

Family MIMIDAE

This northern family has only two representatives, a *Mimus* and a *Donacobius*, the latter a bird of the coastal savannas which is only a straggler at Kartabo. Its amazing antics and remarkable duets make it an interesting type.

Family TURDIDAE

Four thrushes are found, one of them a migrant from the United States. At evening a very wide-spread jungle song is the surprisingly robin-like call of one of these species of *Turdus*. They live in isolated pairs in fairly deep jungle, and seem to remain in almost exactly the same locality throughout the year. The nests are placed on low mossy stumps.

Family VIREONIDAE

Seven vireos of three genera, *Vireo*, *Pachysylvia* and *Vireolanus* occur, all with actions and voices typical of their family.

Family MNIOTILTIDAE

Ten wood warblers, of which four are migrants. Many individuals of the yellow warbler *Dendroica*, however, are found throughout the year. *Granatellus* has been found only twice, and is rare everywhere.

Family MOTACILLIDAE

This decidedly northern family is represented by only a single, rare pipit.

Family FRINGILLIDAE

Of this rather more typically temperate family, seventeen species are found here. About half are clearing birds, the little *Oryzoborus* and *Sporophila* being abundant, most of them singing sweet, untropical songs. The three brightly-colored grosbeaks *Pitylus*, *Periporphyrus* and *Caryothraustes* are wholly jungle birds, almost always found with the antbird flocks.

Arremon is a solitary, silent, terrestrial jungle sparrow, too brightly colored to have been there many generations. It nests on the ground.

Only the clearing seed-eaters are found in flocks of their own kind.

Family COEREBOIDAE

Seven honey-creepers, brightly colored, are all tree-top birds except *Coereba*, which is mid-jungle and clearing. Their nesting habits are varied, *Cyanerpes cyaneus* nesting over water and laying two black eggs. Five are common forms.



Fig. 15. Nest and eggs of *Thraupis Episcopus*, the abundant Blue Saki Tanager of the research area.

Photograph by John Tee-Van.

Family TANAGRIDAE

Tanagers are well represented by twenty-two species. The most familiar birds of the clearing are two *Thraupis* and a *Ramphocelus*, the blue, palm, and silver-beaked tanagers, the latter the most abundant nesting bird in the area. The small euphonias, *Tanagra*, and the larger callistes, *Tangara*, are gregarious, haunt the tree-tops and congregate in jungle berry trees; *Cissopis* and *Lamprospiza* are solitary. No family shows more brilliant coloring, or is more decidedly an element of the tops of the jungle's tallest trees.

Family ICTERIDAE

These twelve species form an important element in the avifauna of Kartabo, and reflect the utmost variety to be found in any one family. The giant orioles, *Ostinops*, build their five-foot nests in

tall trees, and make the jungle ring with their courtship, and after the breeding season associate in flocks with toucans. The two brilliant *Cacicus* fashion shorter nests on lower trees, always in large colonies. *Cassidix* is parasitic upon all three. *Molothrus* is a stray from more open regions, and *Pseudoagelaius* from the inland savannas. *Leistes* haunts every meadow with the habits of our red-winged blackbird, and a delightful flight song. *Melanospar* nests singly in palm trees. The bobolink is a rare migrant.

Family CORVIDAE

A single species represents this northern family, the beautiful lavender jay *Cyanocorax*, whose nesting habits are still a mystery, but which is usually seen in flocks with other birds of similar size, such as toucans and caciques.

Class MAMMALIA

This is a land where birds and insects are dominant. In the quarter square mile of research area, mammals are almost the least noticeable class. A stranger to this tropical region could wander for days through the jungle and catch only the most fleeting glimpse of accourie or deer or monkey. Vocally only the howling monkeys would ever distract his attention from the sounds of insects, amphibians and birds. In numbers, in variety of adaptations and habitat, in pattern, in coloration, in vocal ability, in general keenness of the senses, the Class of which we are members is hopelessly outclassed. Mollusks, and especially shelled snails, are small, obscure and very scarce at Kartabo, and yet in point of numbers they rank with mammals.

The total number of mammals taken or observed within the research area is seventy-three, a number exceeded by all other classes except amphibians. As far as I have been able to enumerate those from the entire Colony, this is about fifty-eight percent of the whole. Bats and the smaller rodents are very inadequately represented in the list, and future collecting will undoubtedly bring the total up to one hundred.

The mammals are divided into ten orders and twenty-seven families. The only order of living Eutheria not represented in the quarter square mile is Insectivora.

In size they range from the great cow-like tapir with a weight of hundreds of pounds, to the tiniest of insect-eating bats, which weigh a bare three grams.

As in the case of the birds, a comparison of the land and fresh-water mammals of New York State with those of a quarter of a square mile at Kartabo is well worth while. In New York, Miller has recorded eighty-one species, while I have listed seventy-three from the limited tropical area—an area which is $\frac{1}{180,000}$ of that of the temperate State.

Eleven orders are represented in the two localities, of which six are common to both, one is found only in New York, and four others occur at Kartabo alone. The relative number of species is as follows:

Orders of Mammals of New York State and of Kartabo			
	New York		Kartabo
Marsupialia.....	1	....	6
Chiroptera.....	8	....	12
Carnivora.....	17	....	13
Rodentia.....	32	....	19
Artiodactyla.....	4	....	4
Cetacea.....	8	....	1
Insectivora.....	9	....	
Edentata.....		....	9
Sirenia.....		....	1
Primates.....		....	7
Perissodactyla.....		....	1

New York State was originally a country varied with open areas as well as forests, while Kartabo is almost wholly jungle or river. This difference is reflected in the relative adaptive radiation of the mammals of the two localities.

Environment Adaptations	New York		Kartabo	
	Species	Percentage	Species	Percentage
Aquatic.....	3	4	7	9.5
Terrestrial.....	53	75	23	31.5
Arboreal.....	7	9.8	31	42.5
Aerial.....	8	11.2	12	16.5

If, instead of the above classification, we add to the strictly arboreal Kartabo species those mammals which are good climbers and spend much of their time in trees, we find that over 60 per cent. of the whole are more or less dependent on the jungle, while the

same test applied to the New York mammals shows only 11 per cent. arboreal.

As regards food, the seventy-three Kartabo mammals divide themselves into thirty-one which are herbivorous, thirty-one carnivorous, and eleven omnivorous.

In a relative summary at Kartabo, mammals (the group to which we ourselves belong), must be reckoned as seventh, preceded by birds, insects, fish, spiders, reptiles and amphibians. We realize that the age of reptiles and of giant mammals is past, and that the present is the age of man, insects and birds.

Many of the Kartabo mammals are nocturnal, almost all are dull-colored, and their senses of eye, ear and nostril are so keen that they are difficult of approach. The following notes which I have already published in the Zoological Society Bulletin on the mammals observed during the month of March, 1922, in the quarter square mile, will serve admirably as an introductory hint of tropical mammalian life as observed in the field.

"Only a few days after our arrival at the Station a herd of about forty wild peccaries, the collared species, came down within a hundred feet of the laboratory, and rooted under fallen logs and jungle floor debris in search of grubs and tubers. One of our party found a tree where a hacka was feeding on five successive days, and a pair of the animals on the sixth. When alarmed the hacka rushes down the trunk, paying no attention to the observer, no matter how close he may be standing, and dashes off through the jungle. A few days later a splendid black jaguarondi cat trotted past me, unhurried and in full view. I do almost no shooting within the quarter mile of area under observation, and hence let him go unharmed. So again, one day, sitting on the old stelling, when an ocelot came and sat down on a rock, we looked at one another and went our ways in peace. Three times during this month I started deer near the trail, and at least half a dozen of the big rodent agoutis have scampered away from their feast of fallen fruit with the commotion of a whole drove of animals. A jaguar has been about ever since our arrival. I found an agouti partly devoured, and the tracks of the big feline show him to be a full-grown animal.

"Every night three families of red howling monkeys roar across the river, and fresh-water dolphins come close to the shore at high tide and sigh as they exhale. Within our own area, there are at least two bands of howlers, two of cebus and one gang of beesa monkeys.

"Strangely enough we have not seen a single opossum this year, but they are here in numbers, and I occasionally hear them at night on the dining room table and running along the partitions of the bungalow. A tamandua anteater was found up a tree just back of the Station, and a great anteater eight feet in length was killed a short time before our arrival. In the stomach of the tamandua were two hundred thousand white ants or termites. Of course it would be impossible to count all these insects. Our method is to take ten cubic centimetres, and divide it into ten equal parts. In each of these there is an average of one hundred and twenty white ants, and when this divided into the accurately gauged mass of the remainder, the result of two hundred and three thousand insects is obtained. When we realize the terrible damage which these insects do to houses and furniture, it would seem the wise thing for tropical planters to encourage these long-tailed tamanduas as much as possible. With a flock of tamanduas to keep the termites down, and a colony of giant marine toads to attend to leaf-cutting ants, much more success would attend tropical agriculture.

"In the pits dug for frogs we have recently taken a spiny rat, a rodent normal in appearance until we rub its fur the wrong way, when the hairs of the back feel like the spines of a porcupine. We keep as pets the beautiful little brown and white mice which come to glean from our crumbs after dinner. Bats are abundant, and we have captured forty-three of the dusky blunt-nosed species in the bungalow, only six of which are males. Two other species have been shot, one new to us, and vampires fly around the tents every night, although no one has been bitten this year. My Indian hunter has brought in agoutis, a wild pig and many monkeys for food, and a beautiful twenty-six pound margay cat. The arboreal character of this animal is shown by its food, it having fed upon a cebus monkey, while the skin of the stomach was punctured in several places by spines of the tree porcupine.

"Thus during the month of March, without any especial search, in the course of tramps for materials dealing with special problems, we have seen twenty species of mammals, with a conservative estimate of one hundred and fifty individuals."

ENEMY AND PREY ECOLOGY

Fourteen species of vertebrates have been found feeding on mammals at Kartabo.

Enemy and prey ecology—continued

Three species of snakes feed on rodents and sloths.

Two owls feed on mice and bats.

Two hawks eat mice.

Three eagles devour monkeys and sloths.

Margay cat eats porcupines, cebus monkeys and sloths.

Ocelot and Jaguarondi eat spiny rats.

Coati eats opossums.

MAMMALIAN FOOD

Earthworms	<i>Nasua</i>
Spiders	<i>Nasua</i>
Scorpions	<i>Nasua</i>
Centipedes	<i>Nasua</i>
Roaches	Opossum
	<i>Nasua</i>
	<i>Molossus</i>
Long-Horn Grasshoppers	Opossum
	<i>Nasua</i>
Tree-Crickets	<i>Saimiri</i>
Beetles	Opossum
	<i>Nasua</i>
Ants	<i>Tamandua</i>
Moths	<i>Nasua</i>
Termites	<i>Molossus</i>
	<i>Tamandua</i>
Lizard Eggs	<i>Nasua</i>
<i>Cophias flavescens</i>	<i>Nasua</i>
<i>Engystoma microps</i>	<i>Nasua</i>
Small Opossum	<i>Nasua</i>
Tree Porcupine	Margay
Spiny Rat	Ocelot
3-toed Sloth	Margay
Cebus Monkey	Margay
Motmot	Margay
<i>Leptodactylus pentadactylus</i>	<i>Lutra</i>

Order MARSUPIALIA

Family DIDELPHIDAE

Out of ten or twelve Guiana opossums, six are found in the quarter square mile research area at Kartabo. The big *Didelphis*, almost exactly like our northern opossum, is a jungle scavenger. The tiny *Marmosa*, carrying sometimes ten young on her back, and the larger *Metachirus* come frequently into the pantry and laboratory. *Monodelphis* is much rarer. It nests in a small form on the ground

in grass, and feeds on beetles and roaches. The rarest of all is the *Chironectes* or water opossum, which I have seen twice but have not yet secured. All are nocturnal and, except the last, arboreal.

Order CHIROPTERA

A dozen species of bats have been recorded. Probably twice as many are present, but have not yet been secured.

Family EMBALLONURIDAE

The little river bats, *Rhynchiscus*, are common along the shore and up the creeks, roosting on the under side of tacubas and mangroves. The only other member of this family so far recorded is *Saccopteryx*, the rare sac-winged bat.

Family PHYLLOSTOMIDAE

Five species are found of which *Phyllostomus* is a very large, leaf-nosed species; the fruit-eating *Vampyrus* is the largest of all the bats occurring here; *Mesophylla* is a rare white jungle bat. I shot six out of eight, all roosting together beneath a large aroid leaf. Finally there are the very common *Glossophaga* and *Hemiderma*.

Family DESMODONTIDAE

The vampire, *Desmodus*, is not uncommon, and most of us have been bitten at one time or another, the bats entering the tents unless a lantern, turned low, is burning somewhere near.

Family FURIPTERIDAE

This flat-faced, small, delicate bat is not rare, and I have taken it in the jungle, up creeks, in the laboratory and in the tents. It is as devoid of expression as a King Charles spaniel, or a sloth.

Family MOLOSSIDAE

These are the common house bats of the Station, from twenty to sixty *Molossus* having to be ejected each year before we can work in peace. *Eumops* is rarer, but comes occasionally into the laboratory.

Order CARNIVORA

Family CANIDAE

Icticyon or hunting dog is the only member of this family found near the Station, and here it is probably a stray from the

inland savannas. A young specimen which was caught by an Indian and which he would not sell, a skull which I picked up, and a skin which was lost in transit are all the data we possess. One of my Indians has killed four near here.

Family PROCYONIDAE

Three mammals of this family make their homes here; *Procyon*, the crab-eating raccoon, is not rare along the river-banks, where its tracks reveal its nocturnal journeyings, and *Nasua*, the coati, comes through the jungle in pairs or families, tearing stumps to pieces, as arboreal as squirrels. At night the flash-light reveals the glowing eyes of the kinkajou, *Potos*, which is much commoner than is supposed.

Family MUSTELIDAE

Two giant weasels, *Tayra* and *Grisson*, inhabit the research area, the former almost common, the latter rare. Both climb trees readily, and give forth a skunk-like odor. *Tayra* will rush down a trunk in one's very face to make its escape.

Two others live in the river, the rare giant *Pteronura*, sometimes six feet long, and the more common *Lutra mitis*, which is seen now and then, playing with its young among the mangroves.

Family FELIDAE

Five cats have been identified, and there is probably another small one which has evaded observation.

The jaguar, *Panthera*, occurs occasionally, and two have been seen on the same day near the laboratory. They kill cattle across the river, but like all other South American mammals, are quite harmless to man if not wounded or robbed of their cubs.

Felis cougar, the puma, has been recorded but once at Kartabo, but three miles down the river I have seen three, and two at Kalacoon. They are small animals and quite as harmless as jaguars.

The jaguarondi, *Herpailurus*, is a handsome, long-tailed black cat, weighing about fourteen pounds. It feeds on *Odontophorus* and large insects. The ocelot, *Leopardus*, is more common than the jaguarondi, but less often taken. I have found it usually when taking a domestic chicken. The last feline is the margay cat, *Margay*, which feeds on an unpalatable diet of spiny rats, spines and all, and is seen only rarely, usually by jack-light.

Order RODENTIA

Family HYDROCHAERIDAE

The capybara, *Hydrochaerus*, is common along the river shore, coming out at night and feeding on the succulent swamp plants. They do much damage to the Indians' crops, and are in turn hunted with dogs, and are delicious eating. The wild representative of the domestic guinea pig is found in the far interior of Guiana. The capybara is its five-foot representative. Two young are born and the immature have lived with us as pets.

Family DASYPROCTIDAE

The most abundant mammal in the research area is the agouti, *Dasyprocta*. My Indian hunters and I have killed one hundred and thirty-five for eating, and yet we hardly ever take a walk through the jungle without seeing or hearing one of these red-rumped rodents. There are one to three at a birth, usually two, and although they breed throughout the year, yet the usual season for births is at the beginning of the rains. They haunt certain trees when the berries or fruit are falling, and it is seldom that a Cuyuru palm or wild plum drop their fruit without attracting many agoutis and labbas. Agoutis seem especially subject to the attacks of *bête rouge*, and their ears are usually covered with hundreds. They weigh from five to ten pounds.

The larger, spotted labba or paca, with the misleading generic name of *Agouti*, is a much more rare animal, occasionally coming close to the laboratory. These animals often suffer from enormous warble fly maggots and a host of fleas. They weigh from twelve to fifteen pounds. One, or very rarely two, young are born, usually early in the long rainy season.

The rarest of this family is the small-tailed agouti, *Myoprocta*. At Kalacoon my Indian once brought in a young animal, and at Kartabo one adult has been taken. As with spider monkeys, the Essequibo seems to be the usual barrier for them, as they are not rare on the east bank, but only occur as strays farther to the west.

Family ERETHIZONTIDAE

The tree porcupine, *Coendou*, is probably more common than we realize, but its nocturnal, arboreal habits prevent its being often found. When it blunders into an Indian's benab or into the pantry it shows no fear upon being discovered, but proceeds to seek for

edibles, knowing that no ordinary assailant dares touch it. It has an overpowering odor, especially before it becomes accustomed to captivity.

Family OCTODONTIDAE

Two spiny rats have been taken rather commonly, *Echimys* and *Proechimys*. They are strictly jungle animals, but are also found commonly on the small islands offshore. They often fall into the pits we dig at the sides of the trails. They are fifteen to eighteen inches long, and weigh less than a pound.

Family MURIDAE

The common house mouse, *Mus*, and rat, *Rattus*, have both been taken at Kartabo, the former twice, the latter once, strays from civilization down-river, but neither has obtained a foot-hold.

Family SIGMODONTIDAE

Eight species of jungle mice and rats have been taken, and many more probably await discovery. These are one *Nectomys*, a common water rat, more common on islands than the mainland, three *Oecomys*, one of which is a new species, a spiny mouse, *Neacomys*, and three *Oryzomys*.

In several of the mice I have found two or three the regular number of young in a litter, a most interesting reduction in number compared with northern species, and comparable with the reduction of the number of eggs in many tropical birds.

Family SCIURIDAE

Two members of this typically northern family occur here, a very rare dwarf squirrel, *Sciurillus*; and a common olive brown squirrel, *Guerlinguetus*, which in size, actions and voice recalls our northern red squirrel. It is one of the noisiest mammals of the jungle, and the only one which dares to remain and scold after it has detected our presence.

Family BRACHYPODIDAE

The three-toed sloth, *Bradypus*, is not common when searched for, yet we have had several dozen during the years of occupancy, and they are probably much more numerous than we imagine. They are good swimmers and I have records of eleven crossing the rivers. I have written a monograph of this species, which will follow this ecological account of Kartabo.



Fig. 16. The Three-toed Sloth, *Bradypus*.

Photograph by William Beebe.

The two-toed sloth *Choloepus* is a much rarer inhabitant of the jungle hereabouts. Sloths are of course wholly arboreal, they are solitary and feed on the leaves of only a very few species of trees.

Family MYRMECOPHAGIDAE

The three ant-eaters form a remarkable triumvirate of mammals specialized for a single type of food. The great antbear *Myrmecophaga* is terrestrial, solitary and rare, being seen only once in a great while. I have sent three live ones up north, the last of which we secured after a long fight from boat and shore. It reaches a length of nine feet over all, and is wholly terrestrial.

The tamandua, with an identical generic name, is much more common, as we have secured about fifteen specimens. It is of medium size, weighs eleven to thirteen pounds and is arboreal, feeding both in the trees and on the ground. The last one examined

contained about 50,000 ants and termites, the proportion being about five of the former to one of the latter.

Cyclopes, the rare silky anteater, has been recorded only twice, and captured once. Small, nocturnal, arboreal, it may be more numerous than we know.

Family DASYPODIDAE

Four species of armadillos live in the quarter mile of research area, the giant armadillo, *Tabassous unicinctus*, which I have seen three times, but secured only twice. An adult measured four feet, six and a half inches, and weighed seventy pounds. The nine-banded armadillo *Dasypus* is less common than the eight-banded one, *Tatu*, whose holes are seen here and there in the jungle. As rare as the giant species is the smallest *Tatoua* of which only two live specimens have been recorded. Jungle scavengers, living alone, and coming out at dark, armadillos are seen only when one sits quietly in some trail.

Order PRIMATES

Family CALLITRICHIDAE

Like tailed agoutis, marmosets, *Cercopithecus*, are rare west of the Essequibo. Five records at Kalacoon and Kartabo are all I have, all in moderately low jungle, all tame, yet scolding loudly.

Family CEBIDAE

Six species of monkeys occur at Kartabo. Red howling monkeys, *Alouatta*, are the most abundant. About seventy-five have been killed for specimens and for eating, and yet in 1924 they were more numerous than ever, nine separate bands being within hearing of the Station. The roaring chorus is the loudest, most awesome and most remarkable of all jungle sounds. They favor high trees in swampy jungle. The white-headed saki or beesa, *Pithecia*, ranks third in numbers and lives in dry jungle. They are silent and only a faint cough reveals their presence. *Saimiri* or squirrel monkeys go in large bands but are very irregular, being common some years and almost absent others. A single specimen of *Saimiri cassaquiarensis* is probably a stray from the Brazilian frontier. The spider monkey, *Ateles*, is rare west of the Essequibo, only two having been observed. *Cebus*, the ring-tailed capuchin, is the commonest monkey next to the howlers, going in large gangs, noisy and quite

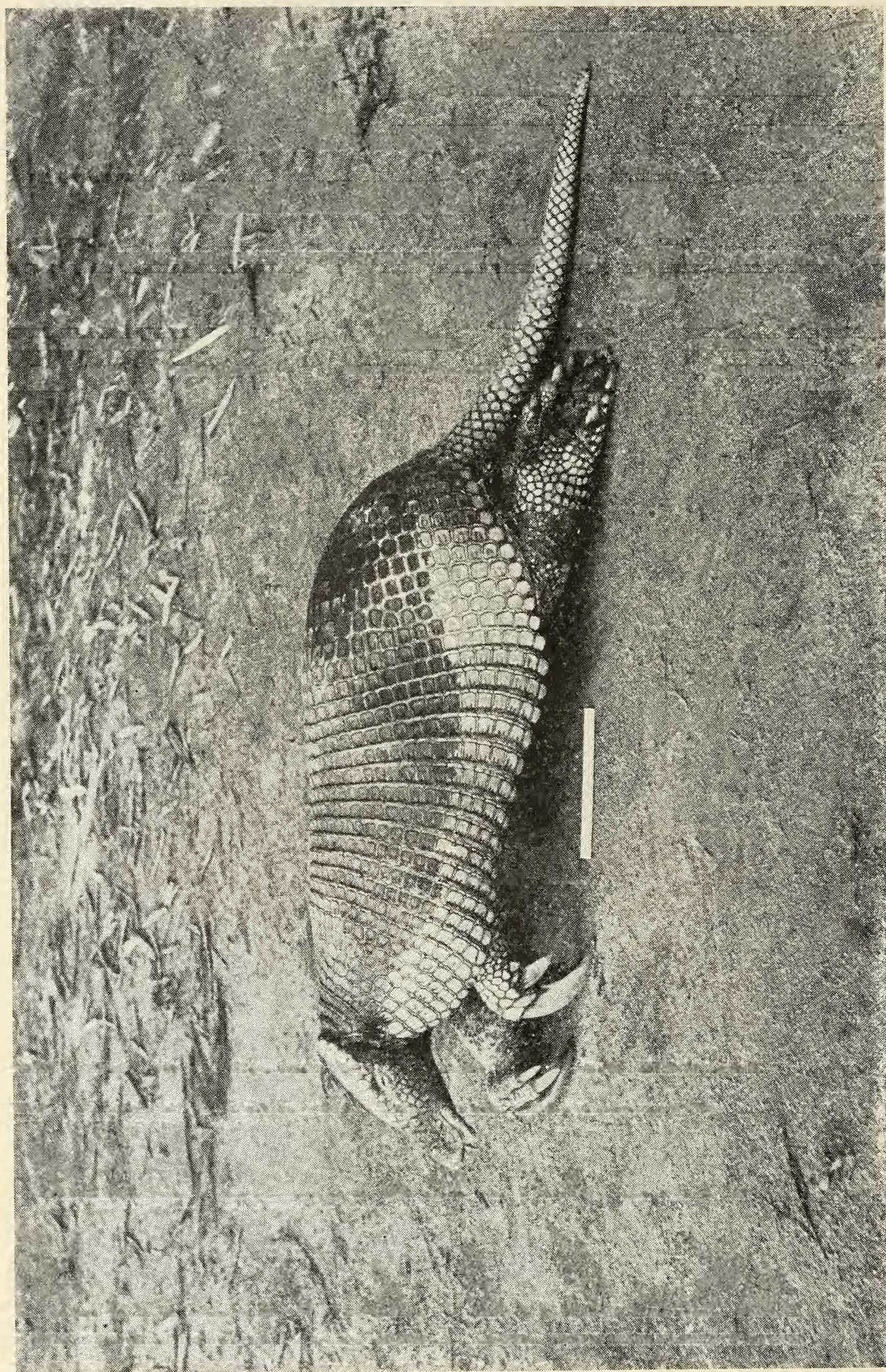


Fig. 17. Giant Armadillo; a rare creature and one of the most difficult to keep alive.

Photograph by John Tee-Van.

fearless. About sixty have been collected, to no appreciable extent diminishing their numbers.

Order ARTIODACTYLA

Family TAYASSUIDAE

Two peccaries are found here, both rather surprisingly being new subspecies. The big white-lipped *Tayassu pecari beebei* is rather rare, but found in large herds when it does occur. The more common collared peccary, *Pecari tajacu macrocephalus*, goes in pairs, families or small herds, and not rarely occurs close to the compound of the laboratory. We have not found them dangerous unless wounded. About forty-five have been killed for specimens and food.

Family CERVIDAE

Two deer, *Mazama*, a large red brocket and a smaller brown one are found, the latter being much more common than the red deer, the proportion shot being about ten to one. They are both small, as deer go, and wholly jungle animals, solitary, or the doe with one fawn.

Order PERISSODACTYLA

Family TAPIRIDAE

The bush cow or tapir, *Tapirus*, is a rare animal in the research area. About one each year is killed and I come across tracks now and then in the deeper parts of the swamps. On February 29th, 1924, a large one was shot close to the laboratory. They are usually found in pairs.

Order SIRENIA

Family TRICHECHIDAE

Twice among the mangroves I have seen manatees, *Trichechus*, and they are not uncommon in the shallows near the creeks across the Mazaruni River. I have taken no specimens since leaving Kalacoon. Near the coast they are numerous, and breed in the Botanical Gardens at Georgetown.

Order ODONTOCETI

Family PLATANISTIDAE

Fresh-water dolphins, *Inia*, are seen on an average of once a week, rolling past as they go up-river, or milling around, feeding in

front of the laboratory. In the shallows between the islands across the Mazaruni, as many as a dozen, old and young, have been seen. Usually from two to six are seen together. The fishermen now and then catch them in their nets. In spite of utmost efforts I have been unable to obtain a specimen.

VII—HISTORY OF KARTABO AND BARTICA DISTRICT

Almost four hundred years ago the fable of El Dorado was credited all over Europe, and created great excitement and a thirst for adventure among all classes of people. This wonderful city of gold was supposed to be located in Guiana, which was, it was said, an empire not inferior to those of Mexico and Peru, and such men as Raleigh formed magnificent conceptions of the civilization to be found beyond the barriers of jungle.

The fabulous city was first known as Manoa, but a Spaniard named Martinez, who claimed to have been there, called it El Dorado, for, he said, on the occasion of a feast the Emperor and all his captains, having first been rubbed with balsam oil, were then covered with gold ground into a fine powder, "until they be all shining from the foot to the head."

The wealth of Guiana was not the only marvel reputed to be found there. The tribe of Amazons, and the headless people whose faces were on their breasts, and the two-fingered negroes were some of the wonders of the country, according to the old tales.

When Columbus made his third voyage to the New World in 1498, he saw the distant northerly coast of Guiana but did not land there. Throughout the 16th century adventurers sought for Guiana, and of course more particularly for El Dorado. Men of all nations tried to be the first to reach the marvellous city where even the most common articles were made of purest gold.

In 1595 Sir Walter Raleigh made his first voyage of exploration up the Orinoco, concerning which he wrote "The Discoverie of Guiana," best of all Elizabethan narratives of adventure, but which was received with incredulity. In 1617 he made a second voyage thither,—a voyage which was a series of disasters.

While Spanish, English and French were eagerly searching for gold, the Dutch were busy trying to build up trade with Guiana. As early as 1580 they had established a settlement on the Pomeroon River, called Nova Zeelandia, and a similar post on Abary Creek,

known as Nibie, or Bush-rope Town. After some years roving bands of Spaniards made the Pomeroon settlement untenable; the inhabitants retired into the interior and went to the point where the Cuyuni River flows into the Mazaruni, just before the latter joins the Essequibo. There they established their headquarters on a tiny island opposite Kartabo Point, which they called Kyk-over-al, because of the wide view it commanded.

This is the earliest settlement in Guiana of which anything remains. When these first settlers came they found there the ruins of a small Portuguese fort, the history of which was unknown even in those days and has remained so.

For a hundred and twenty-four years this dot of land at the confluence of three great rivers was the seat of government of the Dutch colony of Essequibo, which included the extensive region between the Abary and the Orinoco. At first it was chiefly a trading post, where axes, knives, beads and trinkets were bartered with the Indians in exchange for cotton, anatto dye, hammocks, balsam, copaiba and tobacco.

In 1616, soon after Kyk-over-al was settled and christened, this tiny struggling colony was so fortunate as to acquire a man of authority and foresight to direct its destinies. This man was Gromweagle, a Dutchman who had served under the Spanish in various Orinoco expeditions, and had thus acquired so great a liking for Guiana adventures that he sought employment in that part of the world from his own countrymen. He was sent out from Zeeland with three ships, "and was the first man who took firm footing on Guiana by the good liking of his neighbors, whose humours the gentleman perfectly understood."

He rebuilt and strengthened the fort on Kyk-over-al and adopted it as his stronghold. During his time the colony flourished; he was sufficiently wise to adopt a friendly attitude towards all colonists in this part of the world, even carrying this radical policy so far as to trade with the Spanish and English. This, at a time when Dutch, French, Spanish and English were at each others' throats over the question of colonization, and jealousy and suspicion were almost universal among them, must have been a striking phenomenon.

In 1621, the Dutch West India Company was incorporated, and immediately began the introduction of negro slaves. Labor was naturally the crying need of the colonists, for though the land was fertile, the enormous amount of toil required to prepare the jungle

for cultivation needed many more men than had yet been tempted to come from Europe. The climate too, was a serious drawback to a white man's attempts at field labor, and its deleterious effects were not diminished by the quantities of alcoholic refreshment which were considered necessary to repel the dreaded fever. It had been found impossible to persuade the neighboring Indians to look with favor upon honest toil, so the momentous step was taken of importing African slaves.

Three years after this a regular garrison with a Commandeur was sent to Kyk-over-al, which thus became army headquarters as well as trading-centre and prison. Looking to-day at the dimensions of the island, it is hard to believe the records which state that at one time there were more than two hundred soldiers quartered in this small area. They must all have been slaves to the recently discovered vice of smoking, for at the present time it is possible at low tide to retrieve vast numbers of clay pipes from the mud under the ruined walls of the fort. Other relics are there too,—lead bullets and iron cannon-balls, to recall the purpose of this fort in a time of alarums and excursions, fragments of old pottery from the feasts of bush-meat that these sturdy old pioneers enjoyed, and now and then a bright little Dutch bead brought from the far-off Netherlands to tempt the dark and taciturn Indian to part with his small store of cotton or tobacco. Of the fort itself, there remains the archway built of narrow bricks also imported from the mother-country; staunchly fashioned, it still stands, resisting the creeping jungle fingers that seek to pull it down, but the walls, to whose enclosure it once gave access, have crumbled or been carried away to furnish building material elsewhere.

Dutch cultivation spread up the Essequibo, and less extensively up the Mazaruni and Cuyuni. At this time most of the pioneers' efforts were directed toward establishing plantations in the interior, and the subjugation of the jungle went slowly and painfully on.

In the meantime other parts of Guiana were settled. A Dutch colony on the Berbice, English ones on the Surinam and elsewhere, and scattered French settlers on the Cayenne. Up to the beginning of the 19th century Guiana colonies went through a dizzy succession of changes in ownership; British, Dutch and French captured, surrendered and recaptured, while the bickerings between the West India Company and the colonists' Court of Policy were endlessly complicated.

In 1666, an English expedition from Barbados captured Kyk-over-al, but in a few months the English who were left to guard the settlements of the Essequibo district were reduced to thirteen men. They had suffered much hardship through counter-attacks and lack of supplies and were soon forced to surrender to the Dutch.

In 1670, Hendrik Rol was in charge at Kyk-over-al, and during the next few years the West India Company had four large plantations near-by. There was one called Vryheid where Bartica now stands, those of Duinenberg and Fortuin near the present site of Kalacoon House, and Poelwyck on Caria Island.

In 1708, a French privateer under Captain Anthony Ferry sailed up the Essequibo, burning and plundering such settlements as he encountered. Having reached Vryheid, he successfully raided it and the neighboring plantations. The planters took refuge at Kyk-over-al where the Commandeur, one Van Der Heyden, refused to give battle on their behalf, since he had but fifty men to the privateer's three hundred. Ferry sent an officer with a flag of truce to demand ransom, threatening to burn all the estates if this were refused. Van Der Heyden capitulated and agreed to pay fifty thousand florins in slaves, provisions and cash, if Ferry would go without causing further damage.

Richard Schomburgk, who travelled extensively in the interior of Guiana in 1840-1844, gives an interesting account of the origin of the settlement on Kartabo Point, where he went to recruit hands for his inland journey. He says, "The evening having become unusually dark and stormy, we determined to spend the night at Kartabo and return to Bartika first thing on the following morning. The obliging and friendly coloured folk supplied us with hammocks and, though not asked, cleared out a house for our night's quarters, the paddlers preferring the benches and ground spaces. We were up and about by break of day, which gave me an opportunity of having a look over the whole settlement and its occupants.

"The large number of coloured people who inhabit the Essequibo and Mazaruni are mostly descendants of Europeans, negroes and Indians; all belong to the Established Church, and generally stand on a higher plane of civilization than the surrounding Indians. They are the purveyors for the most part of the dried fish supplied to the city, just as they are the builders of the punts, lighters and corials used on the estates, in the manufacture of which they develop unusual

skill. In not too stormy weather, one can even trust oneself at sea in these boats. There is an historical reason for the settlement of this isolated coloured colony here at the junction of three rivers. In the year 1738 some forty odd creole slaves on the possessions of the Dutch Company banded themselves together, secretly left their estates and fled to the Cuyuni where they settled on an island that is still called Creole Island, cultivated some land, and at the same time entrenched themselves fairly strongly. The news naturally had a disquieting effect upon the Governor and plantation-owners, as it was feared that the example taken might be repeatedly followed.

These fears were further increased when the runaways, in their presumption, went so far as to inform the Governor through some Indians that if he wanted to make slaves of them again he must come and fetch them, not only with the whole of his forces but with those of Holland as well, and that they were accordingly awaiting him with confidence in the firm conviction of seeing the attempt on his part completely frustrated. The Governor recognized their advantageous position and at the same time all the difficulties to be encountered in the way of successful attack; he therefore deemed it far better to conclude a favourable treaty than to put to a test the uncertain fortunes of war. A certain Peter Tollenaar, a mulatto, was despatched, unarmed, for the purpose of discussing peace-terms with them on the following lines,—if they did not extend their raids into the Colony but worked every second month for it, and at the same time gave assurance not to entice away any more slaves, the Governor would give them and their descendants their freedom. Peter Tollenaar was successful in his efforts on behalf of peace and from that time up to Emancipation this free and coloured population continued its existence. To prevent their children falling back into slavery, the men were at first allowed to marry only free Indian women.”

For some years there had been a gradual migration toward the coast-lands, for though the interior was far more healthy, the difficulty of combating the jungle, together with the realization that the soil of the coast was better suited to the raising of sugar cane, had determined many planters to brave the miasmas and malarias of the littoral regions. In 1740, under Governor Storm Van Gravesand the seat of government was removed to Fort Island near the mouth of the Essequibo, and the Demerara region began to be more thickly settled. Those of the planters who had not preceded the

Government's move now followed it, and Kyk-over-al was abandoned forever.

Although the Dutch had gone, they left behind more than a deserted fort and a few plantation buildings. That inevitable result of slavery, the half-breed, was present in numbers. In the earlier times the planters had bought Indian slaves from the Caribs, who raided the villages of other tribes and trafficked in their captives. Down to the end of the 18th century Indian slaves were still held, though the trade was prohibited. Thus in every settlement there were the children of Indian women and white men as well as the offspring of African and white, and, in smaller numbers, the results of Indian and negro matings, despite the Indians' dislike of the blacks.

The majority of these people stayed in the jungle after the Europeans had left, and since most of them were totally lacking in the energy which they might have inherited on the paternal side, they relapsed at once into indolence, and did only as much as was necessary for bare existence. Soon the encroaching forest was quietly reclaiming its own, and to-day the gaping archway of Kyk-over-al, leading to nothing but weeds, seems symbolical of the Dutch occupation of this region and its human residue.

There was practically no Government control of this upper region; there was no interest in it, unless runaway slaves were to be hunted, and they seldom got so far as Kartabo, for the Indians were subsidized by the planters to hunt them down. The locality became a sort of refuge for the destitute and for law-breakers, and presently a word was coined to designate these people of three bloods and no race. On the coast they were carelessly referred to as the ones who lived "above yonder," and this becoming corrupted to "boviander" has come to be the name of a people good-natured, shiftless, ignorant and easy prey to disease.

Our nearest neighbor at Kartabo, a boviander woman with kinky hair and coffee-colored skin, used to tell us proudly that her great-grandfather was Governor Van Der Heyden, and that the great tree which overhung our bathing-beach was used for a gallows in the days of which her grandmother had told her.

The strange combination of races resulting in the bovianders, and their proximity to the native Indian tribes has produced many interesting and romantic tales, and it is a pity that so many must have been lost through lack of some one to record them.

A reference to an island that was very likely Kyk-over-al is quoted from an article by Mr. James Rodway in *Timehri* of 1896; "The Indians did not always agree with the bovianders, and in 1805 Postholder Linau was sent up the Essequibo to reconcile the parties in dispute. He met with an Arawak who had abandoned his home because the mulattoes had frightened him with a report that the Acawoios and Macousis were coming down to murder them all. He found the bovianders from Essequibo, Massaruni and Cuyuni congregated on a small island as they said for defense against the Indians."

Bartica was chosen as the site for a mission station in 1829, and this project appears to have flourished for some years, as Schomburgk wrote of it in glowing terms after he visited it in 1841. He particularly described the school for Indian children, whose parents emerged from the jungle once a week on the day when they were permitted by the missionary to visit their offspring. However, when im Thurn was there in 1878, it was abandoned and in ruins.

On the Mazaruni River, on the opposite side from Bartica and a few miles above it, the bank is steep,—almost cliff-like. Here there once stood the residence of a Post-holder, but in 1841 the abandoned house was pulled down and the Penal Settlement was built. This establishment has never been abandoned for lack of patronage, and the fact that it occupies one of the most beautiful and healthy spots in the Colony might almost be regarded as an inducement to crime. The prisoners are mostly negroes and "colored" men, a few Hindus, and rarely a wretched Indian, who neither comprehends the nature of his crime nor the punishment for it. The state of mind of such a captive affords a striking contrast to the equanimity, verging on positive enjoyment, with which most of his colored fellow-inmates regard a sojourn at this spot.

About 1881 gold was discovered in the upper Mazaruni district, and in the wild enthusiasm roused by this find, it almost seemed as though the long-sought El Dorado had been reached at last. Bartica, originally settled as a mission, became the boom town of the gold rush, which has steadily grown in the succeeding years. It was still further augmented not long ago when the discovery of diamonds was made in the same region, and the reports of the housing conditions in Bartica equal the horrors of the slums, though the climate renders sleeping in the streets a pleasure rather than a hardship.

At present the only means of reaching the gold and diamond

fields is by water, and at all hours of day or night one may hear from Kartabo Point the chanteys of the "pork-knockers," as they paddle up the wide river to their tiny claims deep in the jungle. Plans for building a railroad to open up this district are being considered and some day this portion of primitive forest will be as well known as the sugar estates of the coast.

SUMMARY

No fossil remains of extinct animals occur near Kartabo, and no evidences of prehistoric man, except for a single, very beautiful stone axe, which was dug up within two hundred yards of the Research Station.

To-day we are the last white settlement up-river. Three miles below on the north bank of the Mazaruni, is H.M.P.S. just visible as a group of low buildings, and on the south bank the red roof of Kalacoon appears above the jungle, occupied as the Research Station in 1916 (vide *Tropical Wild Life*, Z.S. 1917). Above us on the Mazaruni are a few scattered benabs of half-breeds or bovianders, and of Akawai Indians. Boat-loads of blacks pass up-river in search of gold and diamonds, while a small Government launch plies once a week up the Cuyuni to the foot of the first falls. Connection with the outside world is through small Government steamers which make three weekly trips between Georgetown and the Penal Settlement.

With these exceptions, the race of man exists only by hearsay in these happy regions.